Candidate Name	Centre Number	Candidate Number
		2

WJEC CBAC

GCE AS/A level

1092/01

CHEMISTRY CH2

Merged WJEC Paper 2s with Mark Schemes

January 2010 to June 2016

P.M. THURSDAY, 21 January 2010

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
	11	
TOTAL MARK		

W10 1092 01 1

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 14 may be used for rough work.

Examiner only

SECTION A

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

1. State which **one** of the following bonds is generally the **weakest**. [1]

A Covalent

B Hydrogen

C Ionic

D Van der Waals ....

2. State which **one** of the following formulae represents a compound that can show hydrogen bonding. [1]

A CH_3CH_3

B CH_3OCH_3

C HCl

D HF ....

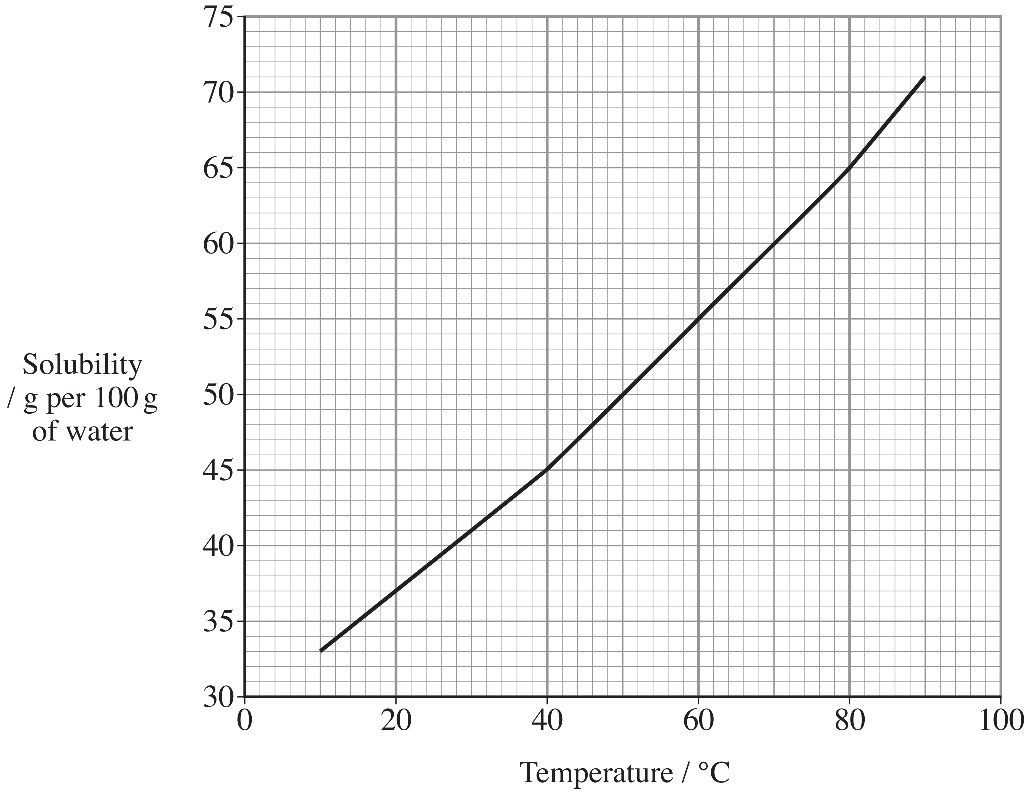
3. Complete the table below by inserting the number of bonding pairs of electrons and name the shapes of the molecules involved. [3]

Molecule	*Number of bonding pairs of electrons in outer shell*	*Number of lone pairs of electrons in outer shell*	*Shape*
$BeCl_2$		0	Linear
PCl_3	3	1	
CCl_4	4	0	

Examiner only

4. Using **outer** electrons only, draw a dot and cross diagram to show the bonding in sodium oxide. Show the charges on the ions formed. [2]

5. The solubility curve for ammonium chloride is shown below.



Calculate the mass of ammonium chloride that dissolves in 50 g of water to form a saturated solution at 30 °C. [2]

....

....

6. Draw the skeletal formula of 2-chloro-3-methylhexane. [1]

Section A Total [10]

Turn over.

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]

....

....

....

....

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

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

....

(ii) Pentane has two structural isomers.

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

....

....

....

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

Isomer 1 Isomer 2

....

Examiner only

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

....

....

....

....

Total [13]

W10 1092 01 5

Examiner only

8. *(a)* In 1928 an American engineer, Thomas Midgley, developed a CFC as a replacement for chloromethane and sulfur dioxide, which were in common use as refrigerants despite being toxic. He showed that the new compound was both non-flammable and non-toxic by inhaling it and using it to blow out a lighted candle.

(i) State the name of the group of compounds often abbreviated to CFC. [1]

....

(ii) State another use to which CFCs have been put. [1]

....

(iii) In the stratosphere, chloromethane breaks down to give chlorine radicals whereas fluoromethane does not break down.

I. Explain what the term ***radical*** means. [1]

....

....

II. Give a reason why chloromethane breaks down but fluoromethane does not. [1]

....

....

(iv) In the 1960s other halogenoalkanes such as $CBrF_3$ were developed as effective fire-fighting materials.

When $CBrF_3$ reacts with aqueous sodium hydroxide, bromide ions are produced. To test for the presence of these ions, dilute nitric acid has to be added first, followed by an appropriate reagent.

I. State why nitric acid has to be added. [1]

....

II. Name the reagent that you would add to test for the bromide ions. [1]

....

III. State what you would see after the addition of the reagent. [1]

....

IV. Write an **ionic equation** for the reaction that confirms the presence of bromide ions. [1]

....

Examiner only

(b) Draw the mechanism for the reaction of bromoethane and $OH^-(aq)$. [3]

Assume the mechanism is the same as for the reaction of 1-chlorobutane and $OH^-(aq)$.

(c) Bromoethane can also undergo an elimination reaction with OH^-.

(i) Name the organic product of this reaction. [1]

....

(ii) State the conditions required. [1]

....

Total [13]

Examiner only

9. *(a)* Compound **A** contains carbon, hydrogen and oxygen only. It has a molar mass of $88.1\ g\ mol^{-1}$. Quantitative analysis of the compound shows that its percentage composition by mass contains 54.5% carbon and 9.10% hydrogen.
Calculate both the empirical and molecular formulae of compound **A**. [4]

....

....

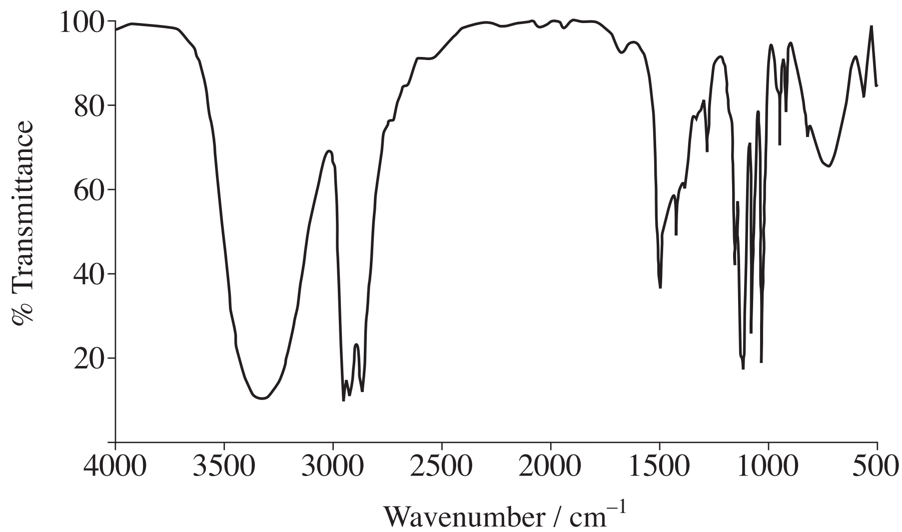
....

....

....

....

(b) Propan-1-ol has the infrared spectrum below.



(i) Using the data sheet, state how this spectrum confirms which functional group is present in propan-1-ol. [1]

....

....

(ii) Propan-1-ol can be completely oxidised to form compound **B**.
Name compound **B** and state how you would expect its infrared spectrum to differ from that of propan-1-ol. [2]

....

....

....

(c) Propan-1-ol can also form propene by a dehydration reaction.
Name a suitable reagent for this reaction. [1]

....

Examiner only

(d) Describe a test, including reagents and expected observations, to show that propene contains a C = C double bond. [2]

....

....

....

(e) Propene can be polymerised to form poly(propene).
Give the formula of the repeating unit in poly(propene). [1]

(f) Substituted alkenes can also be polymerised to give useful polymers.
Name an important polymer formed from a substituted alkene. [1]

....

Total [12]

Examiner only

10. The electronegativities and melting temperatures of some of the elements in Groups 1-7 of the Periodic Table are shown in the table below.
Some values have been omitted.

		Group						
		1	2	3	4	5	6	7
Period 2	Element	Li	Be	B	C graphite	N	O	F
	Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	Melting temperature / K	453	1550	2600	3730	63	54	53
Period 3	Element	Na	Mg	Al	Si	P	S	Cl
	Electronegativity	0.9	1.2	1.5	1.8	2.1	2.5	3.0
	Melting temperature / K	371	923		1680	317	392	172
Period 4	Element	K						Br
	Electronegativity	0.8						2.8
	Melting temperature / K	337						266

(a) (i) Explain the meaning of the term ***electronegativity***. [1]

....

....

(ii) State the trend shown in electronegativity across a period. [1]

....

(iii) Explain this trend. [2]

....

....

....

Examiner only

(b) (i) State the trends shown in melting temperature across Period 2. [2]

....

....

....

(ii) Suggest a value for the melting temperature of aluminium. [1]

....

(iii) Explain why the melting temperature of magnesium is higher than that of sodium. [2]

....

....

....

(iv) Explain why the melting temperatures of the Group 7 elements increase down the group. [2]

....

....

....

(c) Explain, in terms of bonding and structure, why graphite has a very high melting temperature. [2]

....

....

....

Total [13]

Examiner only

11. *(a)* Edmund carries out two experiments with calcium.

(i) In the first experiment, he adds pieces of calcium to water.

I. State what he would **observe** in this reaction. [2]

....

....

....

II. Write a balanced chemical equation for the reaction. [2]

....

III. He repeats the experiment with strontium.

State whether you would expect strontium to be more or less reactive than calcium. Explain your answer clearly. [2]

....

....

(ii) In the second experiment, Edmund reacts pieces of calcium with $20.0\,cm^3$ of $2.00\,mol\,dm^{-3}$ hydrochloric acid.

$$Ca(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2(g)$$

I. Calculate the number of moles of acid used in the experiment. [1]

....

....

II. Calculate the minimum mass of calcium needed to react completely with the acid. [2]

....

....

....

III. Give a test which would confirm the presence of calcium ions in aqueous calcium chloride, stating the result of the test. [2]

....

....

(b) Edmund wants to prepare aqueous sodium chloride using the same method as in *(a)*(ii) opposite. Explain why he should not use this method and state what reagents he could use to obtain aqueous sodium chloride. [2]

....

....

(c) For both calcium chloride and calcium metal:

- state the conditions necessary for each to conduct electricity;
- explain, in terms of bonding and structure, how this process occurs. [4]

QWC [2]

....

....

....

....

....

....

....

....

Total [19]

Section B Total [70]

Turn over.

Examiner only

Rough Work

WJEC
CBAC

GCE MARKING SCHEME

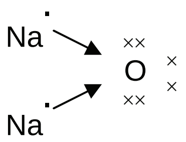
CHEMISTRY (NEW)
AS/Advanced

JANUARY 2010

CH2

Section A

1.	D			[1]
2.	D			[1]
3.	$BeCl_2$	2	(1)	
	PCl_3	pyramidal	(1)	
	CCl_4	tetrahedral	(1)	[3]

4. 

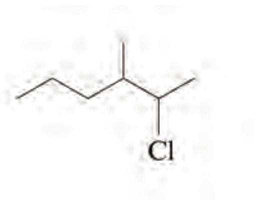
(1)

forming Na^+ and O^{2-} ions (1) [2]

5. Mass in 100 g water = 41 g (1)

Mass in 50 g water = 20.5 g (1) [2]

6.



[1]

Section A Total [10]

Section B

7. (a) Long chain hydrocarbons have more/stronger intermolecular forces (1)
- **van der Waals** forces specified (1)

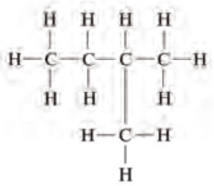
Higher temperatures/more energy required to break these forces (1) [3]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

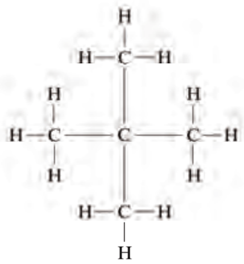
(b) (i) Alkanes [1]

(ii) I Same molecular formula (1)
different structure / arrangement / structural formula / displayed formula (1) [2]

II



(1)



(1)

2-methylbutane (1) 2,2-dimethylpropane (1) [4]

(c) Breaking down of a long chain hydrocarbon into smaller ones (1)

Which are more useful / one of which is an alkene (1) [2]

Total [13]

8. (a) (i) Chlorofluorocarbon [1]

(ii) Anaesthetics / propellants in aerosols / cleaning solvents / blowing plastics / fire extinguishers [1]

(iii) I A species / atom / molecule with an unpaired electron [1]

II C – F bond stronger than C – Cl bond [1]

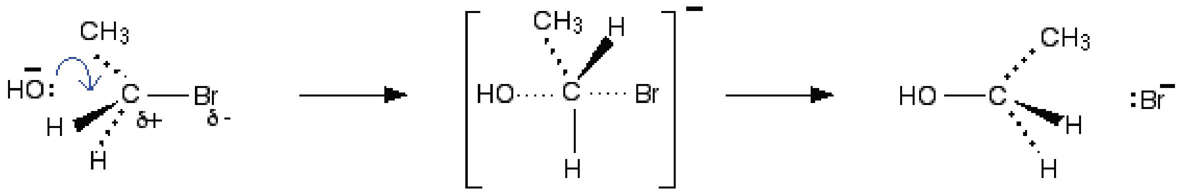
(iv) I To neutralise the sodium hydroxide [1]

II Silver nitrate [1]

III Cream precipitate [1]

IV $Ag^{+} + Br^{-} \longrightarrow AgBr$ [1]

(b)



Reactants:
Polarisation (1)
curly arrow (1)

Intermediate (1)
(accept curly arrow to show
C-Br breaking instead of –ve charge) [3]

(c) (i) Ethene [1]

(ii) In alcohol (and heat) [1]

Total [13]

9. (a)

	C :	H :	O	
%	54.5	9.10	36.4	(1)
moles	4.54	9.01	2.28	(1)
ratio	1.99	3.95	1	

empirical formula = C_2H_4O (1)

molecular formula = $C_4H_8O_2$ (1) [4]

(b) (i) Absorption at about 3300 cm^{-1} characteristic of OH group [1]

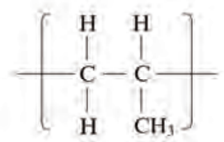
(ii) Propanoic acid (1)

Absorption at around 1700 cm^{-1} due to C = O group (1) [2]

(c) (Concentrated) sulphuric acid / phosphoric acid / aluminium oxide [1]

(d) Add bromine (water) (1)
turns from brown to colourless (1) [2]

(e)



[1]

(f) PVC / Polystyrene / PTFE [1]

Total [12]

10.	(a)	(i)	Ability to attract electrons in a covalent bond/a shared electron pair [1]		
		(ii)	Increases		[1]
		(iii)	Increase in number of protons / charge on the nucleus	(1)	
			But same number of electron shells / no increase in shielding (1)		
			Greater power to attract (bonding pair of) electrons	(1)	[2]
			(1^{st} marking point + 1 other)		
	(b)	(i)	Increases from group I to group IV, large decrease to group V, slight decrease / not much change to group VII (All three trends 2 marks, any two trends 1 mark)		[2]
		(ii)	930 – 1650 K		[1]
		(iii)	Mg has more outer electrons	(1)	
			Therefore stronger bonds since it has more delocalised (valence) electrons / stronger metallic bond	(1)	[2]
		(iv)	Electron cloud / molecular size increases down group	(1)	
			Greater van der Waals / induced dipole forces need to be overcome	(1)	[2]
	(c)		Giant molecular structure (or similar)	(1)	
			with strong covalent bonds between atoms	(1)	[2]

Total [13]

11. (a) (i) I Stream of bubbles / fizzing (1)
White precipitate / cloudiness (1)
Calcium sinks and rises (1)
(any 2 from 3) [2]

II $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ [2]
products (1) balancing (1)

III More reactive (1)
Electrons in strontium lost more easily / ionisation energy is less (1)
(Must have reason to obtain 1st mark)
(More reactive as reactivity increases down group – (1) only) [2]

(ii) I No. moles = $\frac{2 \times 20}{1000}$ = 0.04 [1]

II Moles Ca = 0.02 (1)
Mass Ca = 0.02 x 40.1 = 0.802 g (1) [2]

III Flame test (1)
Flame turns brick-red (1) [2]

(b) Sodium is too reactive to add to acid (1)
Hydrochloric acid + sodium hydroxide / sodium carbonate (1) [2]

(c) Calcium chloride conducts electricity when molten / in solution (1)
Calcium conducts electricity when (molten or) solid (1)
When molten, ions in calcium chloride are mobile (1)
Calcium has delocalised electrons in solid state (1) [4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning (1)
Selection of a form and style of writing appropriate to purpose and to complexity of subject matter (1) [2]

Total [19]

Section B Total [70]

Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1092/01

CHEMISTRY CH2

P.M. THURSDAY, 20 January 2011

1½ hours

FOR EXAMINER'S USE ONLY		
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B	7	
	8	
	9	
	10	
	11	
TOTAL MARK		

1092 010001

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Page 16 may be used for rough work.

Examiner only

SECTION A

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

1. *(a)* Ethanol is present in many intoxicating drinks. Give **one** health problem associated with the consumption of excess ethanol. [1]

....

(b) Ethanol can be converted to ethanoic acid in an oxidation reaction. Give suitable reagents for this reaction. [1]

....

2. Calcium compounds are important in many biological systems. Give an example of where a calcium compound is used in a living organism. [1]

....

3. State which one of the following species has the smallest bond angle. [1]

A CH_4

B H_2O

C BF_3

D NH_4^+

....

4. Write a chemical equation for the displacement reaction that occurs when chlorine gas is bubbled through a solution of sodium bromide, NaBr. [1]

....

Examiner only

5. Use the electronegativity values given in the table below to answer the questions that follow.

Atom	B	H	C	O	Cl
Electronegativity value	2.0	2.1	2.5	3.5	3.0

(a) Identify any dipoles present in the following bonds, marking their polarity clearly.

$$\text{O—H} \qquad \text{C—H} \qquad \text{B—Cl} \qquad \text{C=O}$$

[2]

(b) State which of the bonds in *(a)* will have the largest dipole. [1]

....

6. XeF_2 is one of the few noble gas compounds known. It reacts with water in the presence of a base according to the equation below.

$$2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$$

Complete the table below to give the initial and final oxidation states of the xenon and oxygen atoms, noting whether oxidation or reduction has occurred. [2]

Element	Initial oxidation state	Final oxidation state	Oxidation or reduction
xenon			
oxygen			

Total Section A [10]

1092 010003

Turn over.

Examiner only

SECTION B

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

7. Carnallite is a hydrated chloride mineral that is used as a source of both potassium and magnesium chlorides. It has a formula of $KMgCl_3.xH_2O$. It can also be crystallised from the water of some lakes and seas.

(a) A sample of carnallite is dissolved in water to form a colourless solution. When this solution is tested it behaves as if it is a mixture of potassium chloride and magnesium chloride. Give the expected observations when **each** of the following tests is carried out on a sample of carnallite solution.

Test	Observation
Flame test	....
Addition of nitric acid followed by aqueous silver nitrate	....
Addition of sodium hydroxide solution	....

[3]

(b) Describe how a crystalline sample of hydrated carnallite could be obtained from its aqueous solution. [3]

....

....

....

....

Examiner only

(c) In an experiment, a sample of 3.20 g of hydrated carnallite, $KMgCl_3.xH_2O$, was heated until all water was lost. The mass of the remaining anhydrous sample was 1.95 g.

(i) Calculate the mass, in grams, of water vapour lost from this sample. [1]

....

(ii) Calculate the relative molecular mass of anhydrous carnallite, $KMgCl_3$. [1]

....

....

(iii) Calculate the value of x in the formula $KMgCl_3.xH_2O$. [2]

....

....

....

(d) Magnesium is extracted from carnallite in an industrial process. In order to do this, $MgCl_2$ is initially prepared from carnallite according to the equation below.

$$KMgCl_3 \longrightarrow KCl + MgCl_2$$

1092 010005

Assuming that all the magnesium chloride present can be extracted, calculate the mass of magnesium chloride that could be produced from 100 kg of anhydrous carnallite, $KMgCl_3$. [3]

....

....

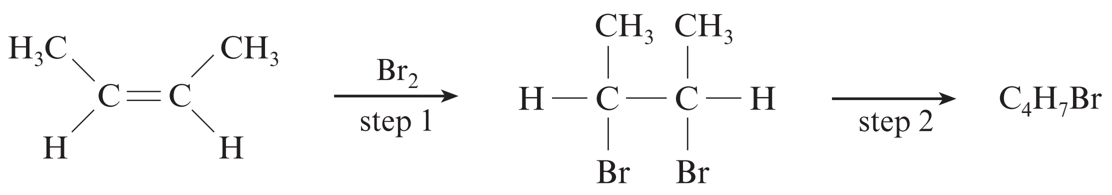
....

....

Total [13]

Examiner only

8. Compound A can be converted to 2-bromobut-2-ene in two steps:



compound A　　compound B　　2-bromobut-2-ene

(a) (i) Compound A exhibits *E-Z* isomerism. Explain why this type of isomerism is possible in this molecule but not in compound B. [2]

....

....

....

(ii) The 2-bromobut-2-ene produced in this reaction is a mixture of two isomers. Draw the **displayed formula** (showing all the bonds) for *E*-2-bromobut-2-ene. [2]

(b) During step 1, compound A is bubbled through bromine water to produce a layer of compound B which does not mix with water.

(i) Give the colour change that would be noted during step 1. [1]

....

(ii) **Name** compound B. [1]

....

(iii) Explain why compound B will not dissolve in water. [1]

....

....

....

Examiner only

(iv) Step 2 is performed using similar reagents and conditions to those used in the production of ethene from bromoethane. Give the reagents and conditions required for this reaction. [2]

Reagents ....

Conditions ....

....

(c) (i) Compound A also reacts with hydrogen bromide, HBr. Give the mechanism for this reaction.

You may assume compound A reacts in a similar way to propene. [4]

1092 010007

(ii) Classify the mechanism of the reaction in *(c)*(i) above. [1]

....

Total [14]

9. Calcium oxide is one of the most widely used industrial materials in the world, with worldwide production being in the region of 283 million tonnes every year.

(a) Most calcium oxide is produced from calcium carbonate by thermal decomposition. The chemical reaction occurring is:

$$CaCO_3 \longrightarrow CaO + CO_2$$

Calculate the atom economy of this process. [2]

....

....

....

(b) Draw a dot and cross diagram to show the formation of calcium oxide from atoms of calcium and oxygen. [2]

(c) Calcium oxide has the same crystal structure as sodium chloride.

(i) Draw the arrangement of ions in the structure of calcium oxide. [2]

(ii) Explain why calcium chloride cannot have the same crystal structure as sodium chloride and calcium oxide. [1]

....

....

Examiner only

(d) Calcium metal reacts quickly with a range of dilute acids.

(i) Write an equation for the reaction of calcium metal, Ca, with phosphoric acid, H_3PO_4, to produce calcium phosphate and hydrogen gas only. [2]

....

(ii) A piece of calcium metal would react quickly with most dilute acids but would not react significantly with dilute sulfuric acid under the same conditions. Explain this lack of reactivity with dilute sulfuric acid. [2]

....

....

....

Total [11]

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]

....

(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]

....

....

....

(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]

....

....

(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]

....

....

....

(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]

....

....

....

....

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

....

....

....

....

(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]

....

....

....

....

....

(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 / $kJ\ mol^{-1}$	Electronegativity difference
C—Cl	338	0.61
C—Br	276	0.41
C—I	238	0.11

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]

Examiner only

11. Part of the Periodic Table is shown below.

Group	1	2	3	4	5	6
	Li		B	C		O
	Na	Mg	Al	Si	P	S
	K	Ca				

(a) Answer the following questions about the elements shown.

Each element may be used once, more than once or not at all.

Write the symbol of

(i) the element with one electron in its 2s orbital, ... [1]

(ii) the element with the lowest first ionisation energy, ... [1]

(iii) an element that forms a basic oxide, ... [1]

(iv) the element with the lowest melting temperature. .... [1]

Examiner only

(b) Graphite, aluminium and caesium chloride are three substances whose structures allow them to conduct electricity under appropriate conditions.

Briefly describe the structure and bonding adopted by **each** and explain how these lead to their ability to conduct electricity. Your answer should include:

- A **brief** description of the structures found in **each** of the three materials;
- An indication of the conditions required for electrical conduction in **each**;
- An explanation of how **each** material conducts electricity. [6]

QWC [2]

....

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....

....

(c) Carbon nanotubes have similar conducting abilities to graphite. Suggest a use for carbon nanotubes that relies on this property. [1]

....

Total [13]

Total Section B [70]

Examiner only

Rough Work

GCE AS/A level

1092/01-A

CHEMISTRY CH2
DATA SHEET

P.M. THURSDAY, 20 January 2011

VP*(W11-1092-01-A)

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Group

Key: A_r (relative atomic mass) / Symbol / Name / Z (atomic number)

s Block — d Block — p Block

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 ▶ La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) ▶▶ Ac Actinium 89															

f Block

▶ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▶▶ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2011

CH2

SECTION A

1. (a) Specific health problem e.g. liver disease / cirrhosis / heart failure / stroke [1]

(b) **Acidified** potassium dichromate(VI) / **Acidified** potassium manganate(VII) [1]

2. Bones / teeth / coral / shells / muscle contraction (accept skeleton) [1]

3. B / H_2O [1]

4. $Cl_2 + 2\,NaBr \rightarrow Br_2 + 2\,NaCl$ or $Cl_2 + 2\,Br^- \rightarrow Br_2 + 2\,Cl^-$ [1]

(State symbols not required)

5. (a) $\delta-$ O-H $\delta+$ $\delta-$ C-H $\delta+$ $\delta+$ B-Cl $\delta-$ $\delta+$ C=O $\delta-$

2 correct for 1 mark, all four for 2 marks [2]

(b) O-H [1]

6.

Element	Initial oxidation State	Final oxidation state	Oxidation or reduction
xenon	+2	0	reduction
oxygen	-2	0	oxidation

1 mark for each line completely correct

(If all oxidation states correct without oxidation/reduction indicated then award 1 mark in total.) [2]

Section A Total [10]

SECTION B

7. (a)

Test	Observation
Flame test	Lilac flame (1)
Addition of nitric acid followed by aqueous silver nitrate	White precipitate (1)
Addition of sodium hydroxide solution	White precipitate (1)

[3]

(b) Heat to evaporate some water to form a saturated solution
(Do not accept evaporate all water or to dryness) (1)

Allow to cool for crystals to form (1)

Filter off crystals / evaporate at room temperature (1) [3]

(c) (i) 1.25 g [1]

(ii) 169.9 / 170 [1]

(iii) Moles carnallite = 1.95 / 169.9 = 1.15×10^{-2} moles
Moles water = 1.25 / 18.02 = 6.94×10^{-2} moles
Both moles for (1)

X = $6.94 \times 10^{-2} / 1.15 \times 10^{-2}$ = 6 (Mark consequentially) (1) [2]

(d) Moles carnallite = 100 000 / 169.9 = 588.6 moles (1)

This produces 588.6 moles of $MgCl_2$ (1)

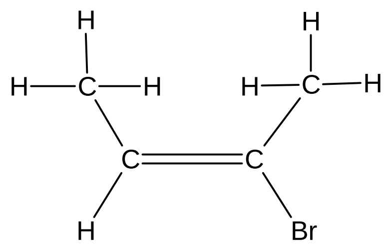
Mass $MgCl_2$ = 588.6 x 95.3 = 56.1 kg or 56100 g
[units must be stated to obtain mark] (1) [3]

Total [13]

8. (a) (i) Compounds A and B have C=C double bonds, but compound B does not (1)

There is restricted rotation **about the double bond** (1) [2]

(ii)



Correct connectivity of bonds (1)

Correct geometrical isomer (1) [2]

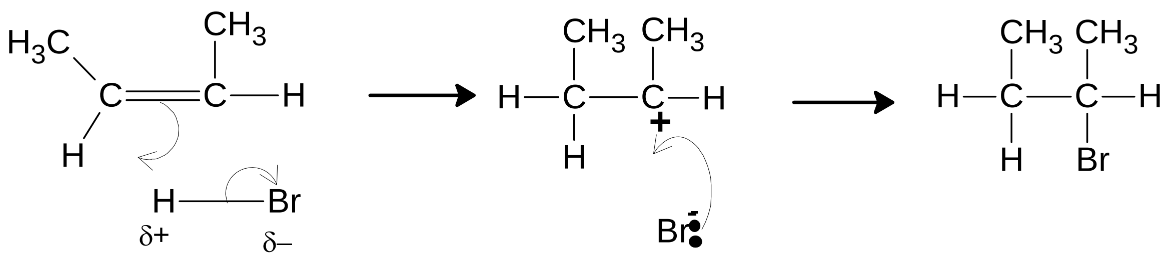
(b) (i) Orange to colourless (do not accept 'clear') [1]

(ii) 2,3-dibromobutane [1]

(iii) Cannot form hydrogen bonds / strong intermolecular forces **with water molecules** [1]

(iv) Sodium or potassium hydroxide (1)
Dissolved in alcohol and heat (1) [2]

(c) (i) 1 mark for arrows in first diagram; 1 mark for dipole on H-Br molecule; 1 mark for arrow in second diagram; 1 mark for charges in second stage [4]



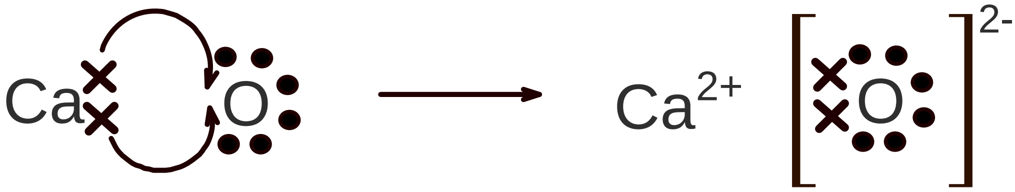
(ii) Electrophilic addition [1]

Total [14]

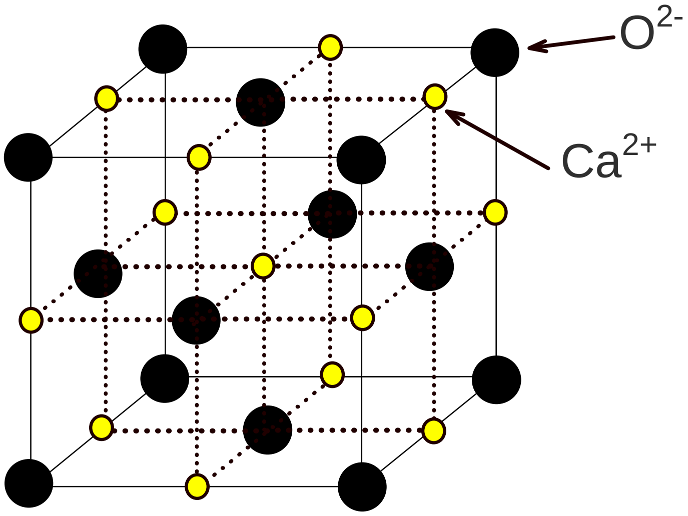
9. (a) M_r ($CaCO_3$) = 100.1 M_r (CaO) = 56.1 both values gives 1 mark

Atom economy = (56.1 /100.1) x 100 = 56.0 % (1) [2]

(b) 1 mark showing movement of electrons; 1 mark showing dot and cross of CaO [2]



(c) (i) 1 mark for cubic arrangement; 1 mark for 6 counterions arranged octahedrally around each ion [2]



Accept smaller diagram that shows the octahedral arrangement of ions around counterions

(ii) (CaO and NaCl have 1:1 formulae), $CaCl_2$ has 1:2 [1]

(d) (i) $3\ Ca + 2\ H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3\ H_2$

1 mark for formula of calcium phosphate; 1 mark for equation

All total of 1 mark for balanced equation with incorrect formula for calcium phosphate
e.g. $2\ Ca + 2\ H_3PO_4 \rightarrow 2\ CaPO_4 + 3\ H_2$ [2]

(ii) Calcium sulfate is insoluble (1)

This produces a **layer** over the surface of the metal preventing reaction (1) [2]

Total [11]

10. (a) $Cl_2 \rightarrow 2\ Cl^{\bullet}$ [1]

(b) Fractional distillation (1)
Different products have **different boiling points** (1) [2]

(c) (i) One intermediate is a $C_5H_{11}^{\bullet}$ radical / a five carbon radical (1)
Two of these radicals combine together in a termination reaction (1) [2]

(ii) Peak at 650-800 cm^{-1} (due to C-Cl bond) in chloropentane will be gone (1)
Peak at 2500-3500 cm^{-1} (due to O-H) in pentanol will be present (also accept 1000-1300 cm^{-1} for C-O bond) (1) [2]

(d) (i) Pentan-1-ol has hydrogen bonding between molecules but 1-chloropentane does not (1)
Hydrogen bonding is the strongest intermolecular force (1) [2]

(ii) Both compounds have similar hydrogen bonding **between molecules** (1)
Pentan-1-ol is a larger molecule than propan-1-ol (1)
Pentan-1-ol has more stronger van der Waals forces **between molecules** than propan-1-ol (1)
Any 2 out of 3 [2]

(iii) Propan-1-ol (1)

-OH can hydrogen bond **with water** (whilst –Cl cannot) (1)

Pentanol has a larger part of the molecule that cannot hydrogen bond / hydrocarbon chain is hydrophobic (1) [3]

(e) C-Cl has the largest δ+ on carbon / C-I has smallest δ+ on carbon (1)

If dipole was controlling factor, C-Cl would be fastest as nucleophile most attracted to this (1)

Easier to break bonds as go down the group / bonds get weaker down the group (1)

If bond strength was the governing factor we would expect rate to become greater down the group (1)

Dipole is not the controlling factor for rate / Bond strength is the governing factor (1)
[MAX 4]

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning. [1]

Total [19]

11. (a) (i) Li [1]

(ii) K [1]

(iii) Li / Na / K / Mg / Ca [1]

(iv) O [1]

(b) Structures (Max 4 points on structure)

- Graphite: Giant covalent structure OR Hexagonal layers of carbon atoms
- Graphite: Delocalized electrons between the layers
- Aluminium: Lattice of **positive** metal **ions**
- Aluminium: (Sea of) delocalized electrons
- Caesium chloride: (Lattice of) anions and cations / giant ionic

Conditions required

- Graphite and Aluminium can conduct as solids
- Caesium chloride must be a liquid/solution to conduct

How material conducts

- Aluminium and Graphite: (Delocalised) electrons move to form a current
- Caesium chloride: **Mobile ions** carry allow electricity to flow

1 mark for each point giving [MAX 6]

QWC: 2 marks [2]

- *selection of a form and style of writing appropriate to purpose and to complexity of subject matter.*
- *organisation of information clearly and coherently; use of specialist vocabulary where appropriate.*

(c) Nanoscale electrical wires / electronic circuitry [1]
(accept miniature/tiny)

Total [13]

Section B Total [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

CHEMISTRY CH2

P.M. THURSDAY, 19 January 2012

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-5	
B	6	
	7	
	8	
	9	
	10	
TOTAL MARK		

1092
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

J A N 1 2 1 0 9 2 0 1 0 1

Examiner only

SECTION A

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

1. 'Smart' alloys have an increasing importance in many applications.
State how 'smart' alloys differ from other alloys in the way in which they act when used for a particular purpose. [2]

....

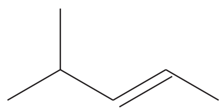
....

2. A small piece of sodium metal is added to water.
Give the equation for this reaction and suggest a pH value for the resulting solution. [2]

Equation ....

pH of solution ....

3. The skeletal formula of a hydrocarbon is shown below.



Give the **systematic name** of this hydrocarbon. [1]

....

4. Police use a breathalyser to test motorists for the presence of alcohol.

(a) An early type of breathalyser required the motorist to breathe into a tube that contained acidified potassium dichromate. The alcohol in their breath was oxidised to ethanal and ethanoic acid. State the colour change that occurred if the test was positive. [1]

.... to ....

(b) Modern breathalysers use infrared spectroscopy to detect and measure the concentration of alcohol in breath. An absorption frequency at 2940 cm^{-1} is used rather than the frequency caused by the O—H bond, as this is also present in water.

(i) Use the Data Sheet to identify the bond that causes the absorption at 2940 cm^{-1}. [1]

....

0 2

(ii) State which **one** of the following correctly describes any change in the absorption at $2940\,cm^{-1}$ if the concentration of alcohol in the breath increases. [1]

A the frequency decreases to $2900\,cm^{-1}$

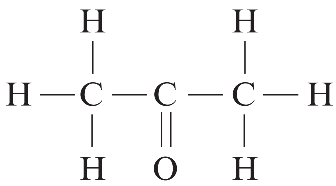
B the frequency increases to $3000\,cm^{-1}$

C the intensity of the absorption at $2940\,cm^{-1}$ increases

D the absorption covers the range 2900 to $3000\,cm^{-1}$

....

(iii) A false breathalyser reading can be given by a person who exhales propanone, as a result of an illness.

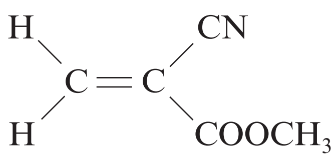


propanone

Identify the bond that would distinguish the infrared spectrum of propanone from that of an alcohol. Using the Data Sheet, state the absorption frequency of this bond. [1]

....

5. 'Superglue' is a liquid containing methyl 2-cyanopropenoate. In the presence of moisture this alkene rapidly polymerises, in a similar way to ethene.
Complete the table showing the structure of the repeating unit. [1]

Monomer	Repeating unit
	

Total Section A [10]

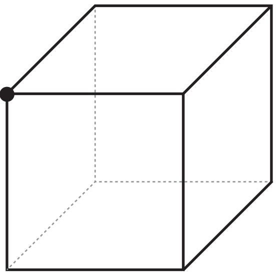
1092 010003

Examiner only

SECTION B

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

6. *(a)* A section of the crystal structure of sodium chloride is shown below.



(i) Indicate, with a cross, the position of any chloride ion on this diagram. [1]

(ii) State the crystal co-ordination number of a **chloride** ion in the structure of sodium chloride. [1]

....

(b) 'Rock salt', used on roads in winter, consists mainly of crystalline sodium chloride that is contaminated by a small quantity of insoluble mudstone.
Gwen added powdered rock salt to water and filtered out the insoluble material. She then evaporated the filtrate to dryness to produce pure white crystals of sodium chloride.
State **two** steps that she should have carried out to ensure that she obtained the **maximum** amount of sodium chloride from her rock salt crystals. [2]

....

....

(c) The minerals 'rock salt', NaCl, and kainite, $KCl.MgSO_4.3H_2O$, both contain chloride ions.

(i) Give a chemical test that produces the same result for both of these compounds. You should state the reagent(s) used and the result of the test. [2]

....

....

(ii) Give a chemical test, other than a flame test, that will show that these two compounds are different. You should assume that they are present as aqueous solutions.
Give the reagent(s) used and the result of the test for each compound. [2]

....

....

....

(d) A common reaction of the halogens is the formation of the anion, X^-.

(i) State, in terms of electronic structure, why this occurs. [1]

....

....

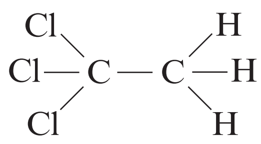
(ii) Give a reason why the tendency to form the X^- ion decreases down the halogen group. [1]

....

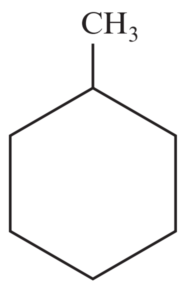
....

....

(e) One compound previously used in correction fluid was 1,1,1-trichloroethane, but this has been replaced by compounds such as methylcyclohexane, which has a much less adverse effect on the environment.



1,1,1-trichloroethane



methylcyclohexane

(i) Explain, in terms of bond strengths, why 1,1,1-trichloroethane has an effect on the ozone layer but methylcyclohexane does not. [2]

....

....

....

(ii) Hept-1-ene is an isomer of methylcyclohexane.

$$CH_3—CH_2—CH_2—CH_2—CH_2—CH{=}CH_2$$

Describe a chemical test that gives a positive result for hept-1-ene but not for methylcyclohexane. [2]

Reagent(s) ....

Observation ....

Total [14]

Examiner only

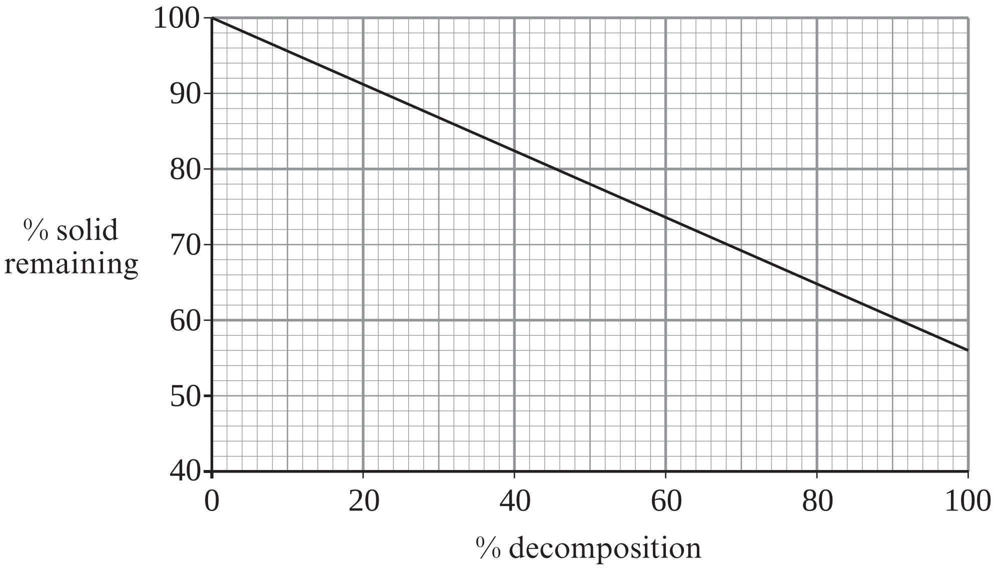
7. *(a)* In industry calcium oxide is made by heating limestone (a form of calcium carbonate) to a high temperature.

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$

(i) This experiment can be repeated in the laboratory by strongly heating a marble chip. Unless the temperature is high enough the reaction is often incomplete.
In an experiment the following results were obtained.

Mass of marble chip before heating	=	3.24 g
Mass of solid after heating	=	2.01 g

Use the graph to help you calculate the percentage decomposition of the marble chip into calcium oxide and carbon dioxide. [2]



....

....

....

(ii) The solid from (i) was carefully added to cold distilled water in order to produce a solution of calcium hydroxide, together with unreacted solid calcium carbonate. The solubility of calcium hydroxide in water was found from the resulting solution. The instructions that were being followed stated

- add the solid to about 1200 cm^3 of distilled water
- stir the mixture for ten minutes
- filter the mixture

I. State why the solid was added to **distilled** water. [1]

....

....

II. State why the mixture was stirred for ten minutes. [1]

....

....

(iii) 1.00 dm^3 of the solution, produced in (ii), was then titrated with hydrochloric acid of a known concentration.

$$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$$

It was found that 0.0450 mol of hydrochloric acid reacted with all the calcium hydroxide present in the solution.

I. State the number of moles of calcium hydroxide that reacted with the hydrochloric acid. [1]

....

II. Calculate the solubility of calcium hydroxide in this solution in $g\,dm^{-3}$. [The molar mass of calcium hydroxide is 74.1 $g\,mol^{-1}$] [1]

....

Solubility = ... $g\,dm^{-3}$

(iv) Calcium carbonate will also react with hydrochloric acid. State why any unreacted calcium carbonate from the marble chip cannot interfere with the experiment in (iii). [1]

....

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Examiner only

(b) Dolomite, $MgCO_3.CaCO_3$, is a mineral found in Italy. State the colour given by dolomite in a flame test, giving a reason for your choice. [2]

....

....

(c) A solution of calcium hydroxide is reacted with aqueous sulfuric acid. A faint white precipitate is seen, as the calcium ions react with the sulfate ions. Give the **ionic** equation for this reaction. [1]

....

(d) The hard mineral fluorapatite, $CaF_2.3Ca_3(PO_4)_2$, is found in tooth enamel.
One weakness with this material is that there are tiny holes between each 'molecule' of fluorapatite and these may be a cause of sensitive teeth.
Recently a manufacturer has suggested that nano-sized fluorapatite particles in a toothpaste may help solve this problem by filling the holes. Suggest what should be done before this nano-sized material is licensed for use. [1]

....

....

(e) Fluorapatite occurs naturally as a rock and can be used to make the fertiliser 'superphosphate'. 5.0 tonnes of fluorapatite give a maximum yield of 8.6 tonnes of superphosphate.
Calculate the mass of superphosphate made from 5000 tonnes of fluorapatite if the percentage yield is 93%. [2]

....

....

....

(f) Radium and calcium are elements in Group 2. Explain why radium carbonate, $RaCO_3$, has a similar formula to calcium carbonate, $CaCO_3$. [1]

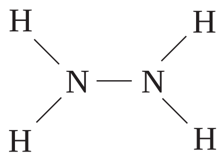
....

....

....

Total [14]

8. *(a)* In 1941 the Germans began to develop a rocket-powered aircraft, the Me 163, for use in the Second World War. The fuel used was based on hydrazine, which reacted with hydrogen peroxide, H_2O_2.

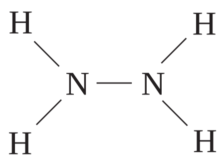


hydrazine

(i) Steam was needed to mix the rocket fuel and the hydrogen peroxide. This was produced by mixing some hydrogen peroxide with the catalyst calcium manganate, $Ca(MnO_4)_2$.
Deduce the oxidation state (number) of manganese in calcium manganate. [1]

(ii) The aqueous hydrogen peroxide used contained 76.5 g of hydrogen peroxide in 100 cm^3 of its solution. Calculate the concentration of the hydrogen peroxide in mol dm^{-3}. [2]

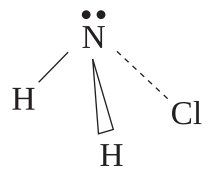
(iii) Hydrazine contains a polar covalent bond between a nitrogen and a hydrogen atom. State what is meant by a *polar covalent bond* and explain how this arises. [2]



(iv) Hydrazine is a weak base and forms hydrazinium chloride, $N_2H_5^+Cl^-$, which contains a co-ordinate bond. State what is meant by the term *co-ordinate bond.* [1]

Examiner only

(v) Hydrazine is manufactured from the compound monochloramine, NH_2Cl.



A probable shape for a molecule of monochloramine is as shown above. The bond angles H—$\hat{N}$—H and H—$\hat{N}$—Cl are around 107°.

Use the valence shell electron pair repulsion theory (VSEPR) and the information given to explain the shape and bond angles. [2]

....

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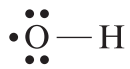
(b) (i) The decomposition of hydrogen peroxide may involve hydroxyl radicals.



State why this is described as a radical. [1]

....

(ii) Another reaction that produces radicals is the reaction of chlorine with methane.

I. Give the equation for the reaction of a methyl radical and chlorine. [1]

....

II. State why the reaction in I above is described as a propagation reaction. [1]

....

....

Examiner only

(iii) Radicals are involved in the cracking of petroleum fractions at 600 °C.

One of the products obtained by cracking is an alkane of molar mass 100 g. Deduce the molecular formula of this alkane. [1]

....

....

(iv) Radicals are produced by the homolytic bond fission of a covalent bond. State what is meant by the term *homolytic bond fission*. [1]

....

....

Total [13]

Examiner only

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]

....

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(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, $CuCl_2$.

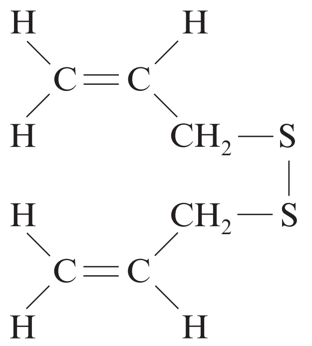
$$2R\text{—}SH + 2CuCl_2 \longrightarrow R\text{—}S\text{—}S\text{—}R + 2CuCl + 2HCl$$

Explain, using the oxidation states (numbers) of copper, why copper chloride, $CuCl_2$, is reduced in this reaction. You should assume that the oxidation state of chlorine is –1. [2]

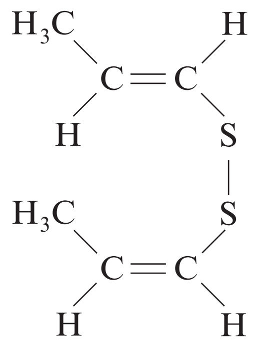
....

....

(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]

....

....

(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]

....

....

....

(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 $C_6H_{10}S_2$. [2]

....

....

....

....

Total [14]

Examiner only

10. *(a)* This question is about the compounds and reactions shown in the diagram below.

$CH_3CH{=}CH_2$ (propene) $\longrightarrow$ $CH_3CHBrCH_3$ (2-bromopropane)

$CH_3CHBrCH_3$ (2-bromopropane) $\longrightarrow$ $CH_3CH(OH)CH_3$ (propan-2-ol)

$CH_3CH(OH)CH_3$ (propan-2-ol) $\longrightarrow$ $CH_3CH{=}CH_2$ (propene)

(i) The addition of hydrogen bromide to propene gives 2-bromopropane as the main product. Complete the outline mechansim below, inserting curly arrows and charges where appropriate. [2]

$$CH_3{-}CH{=}CH_2 \longrightarrow CH_3{-}CH{-}CH_3 \longrightarrow CH_3{-}CHBr{-}CH_3$$

$H^{\delta+}{-}Br^{\delta-}$ $\qquad$ $:Br$

(ii) The reaction of 2-bromopropane to give propan-2-ol is an example of a nucleophilic substitution reaction. Suggest a nucleophile that can be used for this reaction and give a reason why this is classed as a substitution reaction. [2]

Nucleophile ....

Reason ....

....

(iii) The production of propene from propan-2-ol is an example of an elimination reaction. Another elimination reaction is the reaction of bromoethane with sodium hydroxide.

$$CH_3CH_2Br \quad + \quad NaOH \longrightarrow CH_2{=}CH_2$$

Complete the equation by giving the formulae of the other products. [1]

Examiner only

(b) A primary alcohol was oxidised to a carboxylic acid. The mass spectrum of the acid showed a molecular ion at m/z 88.
Use the information provided to write a displayed formula for the acid. [3]

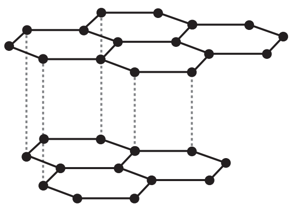
....

....

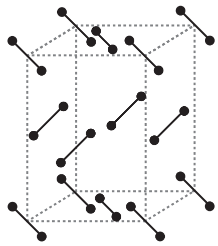
....

....

(c) Both carbon and iodine are non-metallic elements. The crystalline structures of graphite and iodine are shown below.



graphite



iodine

Solid iodine exists as a molecular crystal, I_2.

Explain why graphite is able to conduct electricity but iodine is a non-conductor.
Your answer should focus on the bonding present in each solid element. [5]
QWC [2]

....

....

....

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....

Total [15]

Section B Total [70]

1 5

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GCE AS/A level

1092/01-A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

P.M. THURSDAY, 19 January 2012

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Key: A_r = relative atomic mass; Symbol; Name; Z = atomic number

Period	1	2											3	4	5	6	7	0
	s Block		d Block										p Block					
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) ▸▸ Ac Actinium 89															

f Block

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2012

GCE Chemistry – CH2

SECTION A

Q.1 They show a change in properties with a change in conditions (1)

This change in properties is reversible (1) [2]

Q.2 Equation $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (1)

pH Accept any value 8 to 14 inclusive / above 7 (1) [2]

Q.3 4-methylpent-2-ene [1]

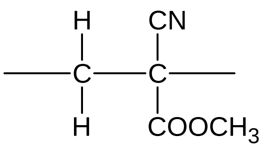
Q.4 (a) Orange to green [1]

(b) (i) C─H [1]

(ii) C [1]

(iii) 1650 to 1750 cm^{-1} C = O [1]

Q.5

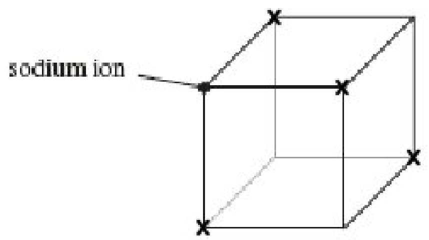


[1]

SECTION A TOTAL [10]

SECTION B

Q.6 (a) (i) [1]



Any of crosses shown

(ii) 6 (not 6,6) [1]

(b) Stir the mixture (before filtering) / heat (1)
Wash the mudstone / residue in the filter paper with water (and add the washings to the filtrate) (1) [2]

(c) (i) Add $AgNO_3$ / Ag^+ ions (assume aqueous) (1) [2]
White precipitate (1)

(ii) Add (aqueous) sodium hydroxide (solution) (1) gives (faint) white precipitate with kainite, no reaction with rock salt (1)

OR

Add barium chloride / barium nitrate / barium ions (1) gives white precipitate with kainite, no reaction with rock salt (1)

OR

Add potassium carbonate / carbonate ions (1) gives white precipitate with kainite, no reaction with rock salt (1) [2]

(d) (i) (The gaining of an electron) gives a full / stable (outer) electron shell [1]

(ii) There is less attraction between the nucleus and the (incoming) electron / oxidising power decreases down the group (increases in size is a neutral answer) [1]

(e) (i) The C–Cl bond (present in 1,1,1-trichloroethane) is **weaker** than the C–H bond (in methylcyclohexane) (1) and is broken by UV light / radicals present (that damage the ozone layer) (1) [2]

(ii) Reagent(s) Bromine (aqueous) (1)
Observation red/ brown $\rightarrow$ colourless / decolourised (1) [2]

Total [14]

Q.7 (a) (i) % of solid remaining $= \frac{2.01 \times 100}{3.24} = 62.0$ (1)

% decomposition = 87 (1) [2]

(ii) I To avoid contamination / ensure that all Ca^{2+} ions came from the solid [1]

II So that all the calcium hydroxide that could dissolve had dissolved / to produce a saturated solution / to ensure homogeneity [1]

(iii) I 0.0225 [1]

II $0.0225 \times 74.1 = 1.67$ (g dm^{-3}) [1]

(iv) Calcium carbonate was removed (by filtration) [1]

(b) Brick red (1)
The 'calcium' will give a flame test colour (1) [2]

(c) $Ca^{2+} + SO_4^{2-} \rightarrow CaSO_4$ [1]

(d) Find out if the nano-particles have 'side effects' / further research to see if they work [1]

(e) 5000 tonnes of fluorapatite give 8600 tonnes of superphosphate (1)

but yield is 93% $\therefore \frac{8600 \times 93}{100} =$ 7998 / 8000 (tonnes) (1) [2]

(f) The two elements both have 2 electrons in their outer energy level / valence shell can both lose 2 electrons to become Ra^{2+} / Ca^{2+} / OWTTE [1]

Total [14]

Q.8 (a) (i) (+) 7 [1]

(ii) M_r H_2O_2 is 34.02 / 34 (1)

Concentration $= \frac{76.5 \times 10}{34.02} =$ 22.49 / 22.5 (mol dm^{-3}) (1) [2]

(iii) A covalent bond where the electrons are not shared equally between the atoms / unequal electron density (1) because of differences in electronegativity between the nitrogen and hydrogen atoms (1) [2]

(iv) A (covalent) bond where **both** electrons come from the same / one atom [1]

(v) (Nitrogen has three bonding pairs and one lone pair of electrons) and these repel each other to take up the position of minimum repulsion (1) The lone pair / bonding pair repulsion $>$ bonding pair / bonding pair repulsion (1) [2]

(b) (i) It contains an unpaired electron [1]

(ii) I $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ [1]

II A radical reacts to produce a new radical (that can continue the process) [1]

(iii) C_7H_{16} [1]

(iv) (Bond fission where a covalent bond breaks) and each atom receives an electron [1]

Total [13]

Q.9 (a) Hydrogen bonding occurs between (1) oxygen, nitrogen or fluorine (1) of one molecule and hydrogen, which is bonded to oxygen / nitrogen / fluorine of another molecule (1)
Alkanes do not contain an O-H, N-H or F-H bond and cannot therefore hydrogen bond to water molecules (1) [4]

QWC Candidates should have use 'a selection and form of writing appropriate to purpose and to complexity of subject matter' [1]

(b) (i) The (purified) petroleum is separated by heating (1) due to the different boiling temperatures of different fractions (1)

OR the mixture is vaporised (1) and then condensed according to boiling temperatures (1) (as at the oil refinery) [2]

(ii) $CuCl_2$ Cu +2 CuCl Cu +1 (1)

(reduction occurs when) the oxidation number becomes less positive (1) [2]

(c) (i) Same molecular formula but a different structural formula / structure [1]

(ii) Both of the carbon atoms of the double bond have different atoms / groups bonded to them (1)
There is no free rotation about the double bond (1) [2]

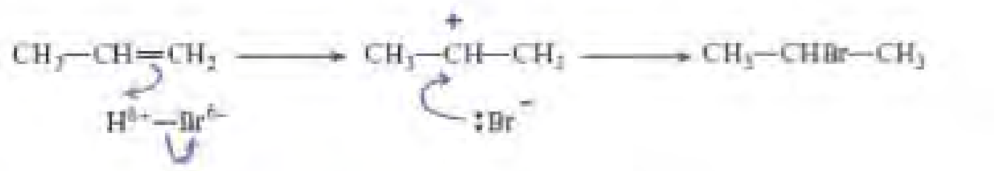
(iii) M_r of compound **A** is 146.3 / 146 (1)

Cost per mole is $\frac{146.3 \times 48 \times 100}{100 \times 73}$ = £96.20 (1)

(Accept £96.00 per mole if M_r of 146 has been used) [2]

Total [14]

Q.10 (a) (i)



curly arrows (1)
charges (1) [2]

(ii) Nucleophile hydroxide ion / OH^- / water (1)

Substitution the replacement of one functional group by another (1) [2]

(iii)

CH_3CH_2Br + NaOH → CH_2 CH_2 + **NaBr** + **H_2O**

(accept **Na^+** and **Br^-** in place of NaBr) [1]

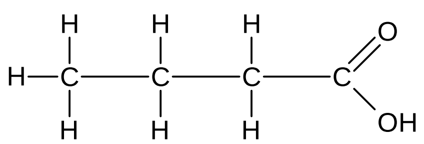
(b) M_r = 88 (1)

'M_r' R = 88 - (45) = 43 (1)

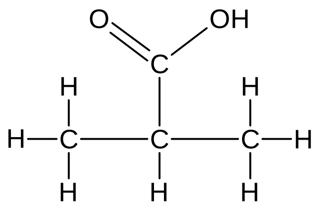
COOH

∴ R (an alkyl group) is C_3H_7

thus acid is



or



(1) [3]

(c) In graphite each carbon atom is bonded to three other carbon atoms (1) (using covalent bonding)
The other (outer) electron for each carbon atom is delocalised (1), throughout the structure and is able to move (1), conducting electricity
In iodine the two iodine atoms are bonded together (using covalent bonding) and there are no free electrons to carry the charge (1)
Mention of covalent bonding for either element (1) [5]

QWC *Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning (1)*
Organisation of information clearly and coherently; use of specialist vocabulary where appropriate (1) [2]

Total [15]

SECTION B TOTAL [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

CHEMISTRY – CH2

A.M. WEDNESDAY, 16 January 2013

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-7	
B	8	
	9	
	10	
	11	
	12	
TOTAL MARK		

1092
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

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Examiner only

SECTION A

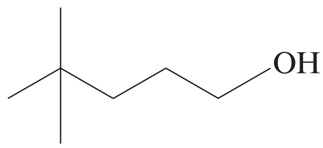
Answer **all** *questions in the spaces provided.*

1. Calcium and magnesium are essential elements in living things. Give **one** use of each element in biological systems. [1]

Magnesium ....

Calcium ....

2. Give the **systematic** name of the molecule shown below. [1]



....

3. The electronegativity values of the halogens are listed below.

Atom	F	Cl	Br	I	At
Electronegativity value	4.0	3.0	2.9	2.6	2.2

(a) Define the term *electronegativity*. [1]

....

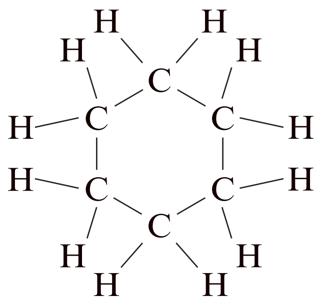
....

(b) Use the data in the table to identify any dipoles present in the following bonds, marking their polarity clearly. [1]

F — Cl   At — Cl

Examiner only

4. Cyclohexane is an example of a hydrocarbon containing a ring of carbon atoms. Its structure is shown below.



Give the **empirical** formula of this compound. [1]

....

5. *(a)* Write the letter corresponding to the correct electronic structure of an atom that is a member of the *d*-block in the box below. [1]

A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$

B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

(b) Write the letter corresponding to the electronic structure of the atom with the highest first ionisation energy in the box below. [1]

A $1s^2 2s^2 2p^6 3s^2 3p^6$

B $1s^2 2s^2 2p^6$

C $1s^2 2s^2 2p^6 3s^2$

D $1s^2 2s^2 2p^6 3s^2 3p^4$

1092
010003

Turn over.

Examiner only

6. The gas oxygen, O_2, is converted into ozone, O_3, in the upper atmosphere. The equation for this process is:

$$3O_2 \longrightarrow 2O_3$$

Use oxidation states to explain why this is not a redox reaction. [2]

....

....

....

7. Recent advances in chemistry have produced a range of smart materials.

Give the meaning of the term *smart material*. [1]

....

....

....

Total Section A [10]

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1092
010005

Examiner only

SECTION B

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

8. Barium chloride is a highly toxic compound that is frequently used in the laboratory.

(a) Aqueous barium chloride can be used to test for sulfate ions in solution.

(i) Write an **ionic** equation for the reaction that occurs when aqueous barium chloride is added to a solution containing sulfate ions. [1]

....

(ii) Give the observation expected for a positive result in this chemical test. [1]

....

(b) A solution of barium chloride can be identified using separate tests for barium ions and chloride ions.

(i) A flame test can be used to prove that the solution contains barium ions. State the flame colour that would be seen. [1]

....

(ii) Give a chemical test to show that the solution contains chloride ions. Your answer should include the reagent(s) and expected observation(s). [2]

Reagent(s) ....

Observation(s) ....

(c) The solubility of barium chloride at two different temperatures is given in the table below.

Temperature / °C	Solubility of $BaCl_2$ / g dm^{-3}
0	312
20	358

Calculate the mass of solid barium chloride that would be obtained by cooling 200 cm^3 of a saturated solution of barium chloride from 20 °C to 0 °C. [2]

Mass = ... g

Examiner only

(d) When solid barium chloride is crystallised from solution, it produces the hydrate $BaCl_2.xH_2O$. The relative molecular mass (M_r) of this hydrate was found to be 244. Calculate the value of x in this formula. [2]

x = ...

(e) Jack wishes to prepare a solution of barium chloride starting with the insoluble solid barium carbonate and dilute hydrochloric acid.

(i) Write the equation for this reaction. [1]

....

(ii) Jack measured $50.0\,cm^3$ of hydrochloric acid of concentration $0.500\,mol\,dm^{-3}$.

I Calculate the number of moles of hydrochloric acid in this solution. [2]

Moles of hydrochloric acid = ... mol

II He added an excess of solid barium carbonate to the dilute hydrochloric acid. Suggest how a pure solution of barium chloride could be obtained from the reaction mixture. [1]

....

III Calculate the maximum mass of hydrated barium chloride (M_r = 244) that could be produced in this reaction. [2]

Maximum mass of hydrated barium chloride = ... g

Total [15]

1092 010007

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]

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(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]

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....

(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 ....

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_3Cl	249
methanol, CH_3OH	338

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

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(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) ....

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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 CCl_3F 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)
A	CHF_3	243 years	0.01
B	CCl_2F_2	20 years	0.86
C	CCl_3F	75 years	1.00
D	$CBrClF_2$	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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Total [16]

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Examiner only

10. Aluminium, boron and nitrogen all form chlorides containing three chlorine atoms, XCl_3.

(a) Molecules of boron chloride, BCl_3, and molecules of nitrogen chloride, NCl_3, have different shapes.

Use VSEPR (valence shell electron pair repulsion) theory to state and explain the shapes of these molecules. [6]

QWC [2]

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Examiner only

(b) The boron atom in boron chloride, BCl_3, is described as being electron deficient. Draw a dot and cross diagram for BCl_3 and use it to show what is meant by the term *electron deficient*. [2]

....

....

(c) Nitrogen chloride, NCl_3, is insoluble in cold water whilst the similar compound ammonia, NH_3, is very soluble. Explain this difference in behaviour. [2]

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(d) Aluminium chloride, $AlCl_3$, forms a dimer that contains both covalent bonds and coordinate bonds. Describe what is meant by the terms *covalent bond* and *coordinate bond*. [2]

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Total [14]

Examiner only

11. *(a)* Both sodium chloride and caesium chloride have giant ionic structures.

(i) Draw a labelled diagram to show the arrangement of ions in a crystal of caesium chloride. [2]

(ii) Give a reason why sodium chloride has a different structure from caesium chloride. [1]

....

....

Examiner only

(b) Both diamond and graphite have giant covalent structures.

(i) Describe the structure and bonding in graphite. [3]
QWC [1]

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(ii) Explain why graphite can conduct electricity whilst diamond cannot. [2]

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(iii) Iodine, I_2, also contains covalent bonds. Explain why solid iodine can be converted into a vapour at a much lower temperature than diamond. [3]

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Total [12]

Examiner only

12. But-2-ene is a useful starting material for the production of synthetic rubber.

(a) But-2-ene can be produced from crude oil by fractional distillation and then cracking.

(i) Explain why fractional distillation can be used to separate molecules with different numbers of carbon atoms. [1]

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(ii) Write the equation for a cracking reaction that produces but-2-ene from decane, $C_{10}H_{22}$. [1]

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....

(b) Bromine solution can be used to distinguish between but-2-ene and butane.

(i) Give the colour **change** that would be expected when bromine solution is added to but-2-ene. [1]

....

(ii) In a similar reaction hydrogen bromide reacts with propene.

Draw the mechanism of the reaction of propene with hydrogen bromide indicating clearly all charges and the movement of electrons. [3]

Examiner only

(iii) Propene can be produced from the product in part (ii) by using sodium hydroxide.

Give the condition(s) required for this reaction. [1]

....

....

(c) But-2-ene can exist as *E*- and *Z*-isomers.

(i) Explain why but-2-ene can form *E*- and *Z*-isomers whilst propene and butane cannot. [2]

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(ii) Draw the **skeletal** formula for *Z*-but-2-ene. [1]

(d) In industry, butan-2-ol can be produced from but-2-ene. This uses the same reagent(s) and condition(s) as the production of ethanol from ethene.

(i) Give the reagent(s) and condition(s) used for this reaction. [2]

Reagent(s) ....

Condition(s) ....

(ii) Explain how infrared spectroscopy can be used to distinguish between butan-2-ol and but-2-ene. [1]

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Total [13]

Total Section B [70]

END OF PAPER

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Examiner only

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Examiner only

Turn over.

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Examiner only

GCE AS/A level

1092/01-A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

A.M. WEDNESDAY, 16 January 2013

SM*(W13-1092-01A)

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Group

s Block · d Block · p Block · f Block

Key: A_r (relative atomic mass) / Symbol / Name / Z (atomic number)

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ▸▸ Actinium 89															

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2013

GCE CHEMISTRY - CH2

JANUARY 2013 MARK SCHEME

SECTION A

Q.1	Calcium – Bones, teeth, muscle contraction. Magnesium – chlorophyll, activation of ATP. (Both for 1 mark)		[1]
Q.2	4,4-dimethylpentan-1-ol (1)		[1]
Q.3	(a)	Ability of atom to attract electrons <u>in a</u> covalent <u>bond</u> towards itself.	[1]
	(b)	δ- F-Cl δ+ δ+ At-Cl δ- Both needed for mark	[1]
Q.4	CH_2 (Accept H_2C)		[1]
Q.5	(a)	C	[1]
	(b)	B	[1]
Q.6	Both O_2 and O_3 have oxidation states of zero (1) No change in oxidation state (1)		[2]
Q.7	Reversible change in properties when conditions change.		[1]

Total Section A [10]

SECTION B

Q.8	(a)	(i)	$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (state symbols not required)	[1]
		(ii)	white precipitate	[1]
	(b)	(i)	apple-green / yellow-green (no credit for 'green')	[1]
		(ii)	Reagents – silver nitrate (1) Observation – white precipitate (1) Must have correct reagent to get observation	[2]
	(c)		Mass produced by cooling 1 dm^3 = 358-312 = 46 g (1) Mass produced by 200 cm^3 = 46 x 200 ÷1000 = 9.2 g (1)	[2]
	(d)		M_r of anhydrous $BaCl_2$ = 208 (1) Water content = 36 so *x* =2 (1)	[2]
	(e)	(i)	$BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$	[1]
		(ii)	I. Moles = 50 x 0.50 ÷ 1000 (1) = 0.025 moles (1)	[2]
			II. Filtration	[1]
			III. Moles $BaCl_2$ = moles HCl ÷ 2 = 0.0125 mol (1)	
			Mass hydrated $BaCl_2$ = 0.0125 x 244 = 3.05 g (1)	[2]

Total [15]

Q.9	(a)	(i)	ultraviolet / sunlight	[1]
		(ii)	A species with an unpaired electron.	[1]
	(b)	$CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$ (1) $CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ (1)		[2]
	(c)	(i)	Two $CH_3\bullet$ radicals combine (in a termination reaction).	[1]
		(ii)	$24.3 \div 12 = 2.025$ for C $4.1 \div 1.01 = 4.059$ H $71.6 \div 35.5 = 2.017$ Cl (1) CH_2Cl (1)	[2]
	(d)	(i)	Nucleophilic substitution	[1]
		(ii)	Methanol has hydrogen bonding between molecules (1) Chloromethane has van der Waals forces / dipole-dipole forces between molecules (1) Hydrogen bonding is stronger than Van der Waals/dipole-dipole (1)	[3]
		(iii)	Acidified potassium dichromate / acidified potassium manganate(VII) (1) Heat /warm (1) (Need correct reagent to gain heat mark)	[2]
	(e)	Compounds **B** and **C** are stable enough to reach the ozone layer OR Compound **D** would not reach the ozone layer as it would decompose in the lower atmosphere. (1) (The C-Cl forms) Cl• which will decompose the ozone. (1) Compound **A** does not contain chlorine, (so it cannot form Cl•) / Compound A has a lower RODP (1)		[3]

Total [16]

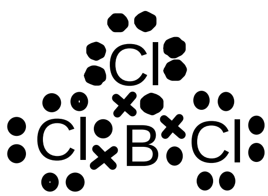
Q.10 (a)

- BCl_3 is trigonal planar or clear diagram.
- NCl_3 is pyramidal or clear diagram.
- BCl_3 has 3 bonded pairs
- NCl_3 has 3 bonded pairs
- NCl_3 has a lone pair
- BCl_3 has no lone pair
- Electron pairs repel to be as far from each other as possible / position of minimum repulsion.
- Lone pairs repel more than bonded pairs.

First two points and any other 4 for (1) each up to 6 max [6]

- *QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter.[1]*
-
- *QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning.[1]* [2]

(b)



accept crosses and dots exchanged (1)

Electron deficient: outer shell of boron has less than 8 electrons / is not full.(1) [2]

(c) NH_3 can form hydrogen bonds with water molecules (so it dissolves) (1)
NCl_3 cannot form hydrogen bonding. (1) [2]

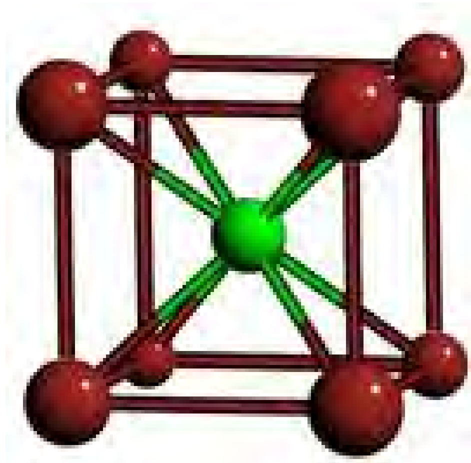
(d)

- Covalent has a pair of shared electrons one from each atom (1)
- Coordinate has a pair of shared electrons both electrons from same atom (1)

[2]

Total [14]

Q.11 (a) (i)



Clear 8 coordination number (1)
Labels of both Cl^- and Cs^+ (either way round) (1) [2]

(ii) Cs^+ ion larger than Na^+ so can have a larger coordination number. [1]

(b) (i) Any three from the following for (1) each up to 3 max – can gain these from labelled diagram

- Layers of carbon atoms.
- Hexagons of carbon atoms / each carbon bonded to three others.
- Weak forces between layers.
- Delocalised electrons above and below plane. [3]

QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate. [1]

(ii) Delocalised electrons in graphite can move to carry a current (1)
Diamond has no delocalised electrons (1) [2]

(iii) Van der Waals forces between molecules need to be broken to form iodine gas (1)

Covalent bonds need to be broken to form a gas from diamond/graphite (1)

Van der Waals forces are much weaker than covalent bonds (1)
[3]

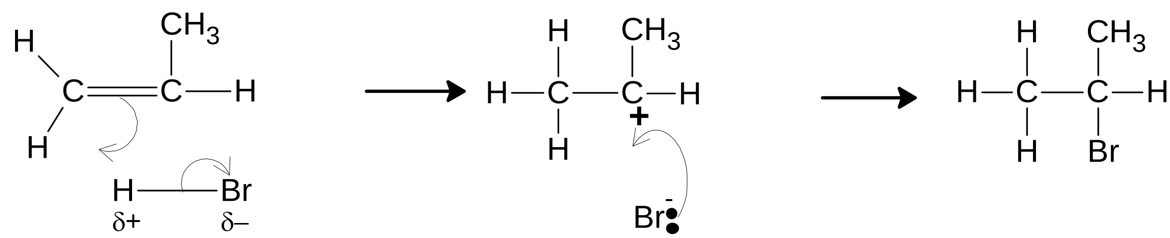
Total [12]

Q.12 (a) (i) Molecules with different numbers of carbon atoms have different boiling points. [1]

(ii) Any suitable reaction, e.g. $C_{10}H_{22} \rightarrow C_4H_8 + C_6H_{14}$ [1]

(b) (i) Turns from orange to colourless (no credit for 'red') [1]

(ii) (1) for arrows in first diagram; (1) for arrow in second diagram; (1) for all charges.



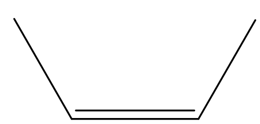
[3]

(iii) Ethanol OR Alcohol solution / Heat - both required [1]

(c) (i) Restricted rotation about double bond in but-2-ene but not butane (1)

2 groups attached to each carbon of the double bond are different in but-2-ene but in propene one carbon has the same two groups attached (1) [2]

(ii)



Accept any valid representation [1]

(d) (i) Steam, phosphoric acid catalyst, (1) 300°C, 70 atm pressure (1) [2]

(ii) Butan-2-ol will have IR absorptions at 2500-3550 cm^{-1} / 1000 – 1300 cm^{-1} and butene will not
OR
But-2-ene will have an IR absorption at 1620-1720 and butan-2-ol will not [1]

Total [13]

Total Section B [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

CHEMISTRY – CH2

A.M. THURSDAY, 16 January 2014

1 hour 30 minutes

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1.7.	10	
Section B	8.	12	
	9.	16	
	10.	16	
	11.	12	
	12.	14	
	Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the continuation page(s) at the back of the booklet, taking care to number the question(s) correctly.

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010001

Examiner only

SECTION A

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

1. State which **one** of the following is a correct statement.

A The first ionisation energy of the elements increases down Group 1

B The melting temperature of the elements decreases down Group 7

C The first ionisation energy of the elements increases across Period 2

D The elements in Group 2 become more electronegative down the group

[1]

2. Chlorine monofluoride has the following formula.

Cl — F

(a) Indicate the polarity in the bond shown by use of the symbols δ^+ and δ^-, giving a reason for your answer. [1]

....

....

(b) Draw a dot and cross diagram to illustrate the bonding between the two atoms in chlorine monofluoride. Include **all** *outer* shell electrons. [1]

3. State why a fluoride ion, F^-, is more stable than a fluorine atom. [1]

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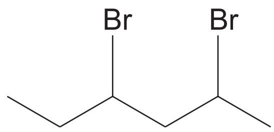
Examiner only

4. *(a)* State the **molecular** formula of compound **L** that has the skeletal formula shown.



.... [1]

(b) Compound **L** reacts with alcoholic sodium hydroxide solution to give hex-1,3-diene as one of the products.

State the type of reaction that has occurred. [1]

....

5. In industry, ethanol is produced by reacting ethene with water / steam.

State the conditions of temperature and pressure used for this reaction. [1]

Temperature ....°C *Pressure* .... atm.

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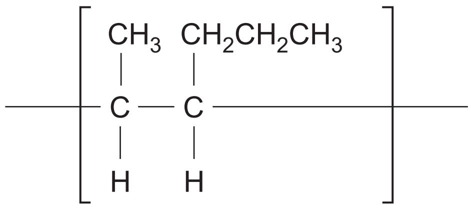
6. A section of an addition polymer is shown below.



State the **systematic name** of the monomer that gives this polymer. [1]

....

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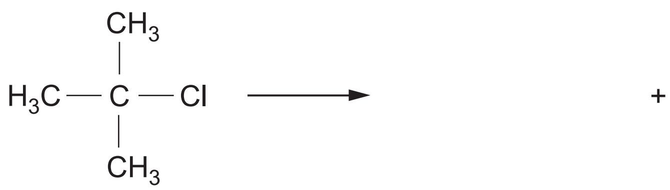
7. *(a)* State the meaning of the term *heterolytic fission*. [1]

....

....

(b) Complete the equation below to show the products of the heterolytic fission of the C—Cl bond in 2-methyl-2-chloropropane. [1]



Total Section A [10]

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SECTION B

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

8. Sulfur difluoride dioxide (sulfuryl fluoride), SO_2F_2, is used as a gaseous insecticide to control termite infestations in wooden houses.

(a) It can be produced by reacting together sulfur dioxide and fluorine.

$$SO_2 + F_2 \longrightarrow SO_2F_2$$

Use the oxidation numbers of sulfur to show that sulfur has been oxidised in this reaction. In your answer you should state how changes in oxidation number are related to oxidation. [2]

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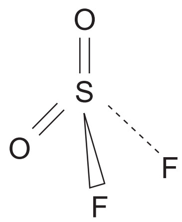
(b) Sulfuryl fluoride is a tetrahedral molecule where the sulfur atom has no lone pairs of electrons.



Use the valence shell electron pair repulsion theory (VSEPR) to state why sulfuryl fluoride has this shape. [1]

....

....

(c) Ammonia reacts with sulfuryl fluoride to give sulfamide, $SO_2(NH_2)_2$. During this reaction ammonia reacts as a nucleophile.

(i) State the meaning of the term *nucleophile*. [1]

....

....

(ii) Give the **formula** of another nucleophile. [1]

....

(iii) Organic reaction mechanisms involving nucleophiles (for example the conversion of 1-chlorobutane into butan-1-ol) often use a curly arrow ( ).

State what this curly arrow represents. [1]

....

Examiner only

(d) Sulfuryl fluoride reacts rapidly with calcium hydroxide to give calcium sulfate, calcium fluoride and water as the only products.

Give the equation for this reaction. [2]

....

(e) Bromomethane, CH_3Br, was formerly used as a fumigant gas to remove insect infestation but has now been largely replaced by sulfuryl fluoride. One reason for this change is that bromomethane has an adverse effect on the ozone layer.

(i) Explain how **both** bromomethane and CFCs have an adverse effect on the ozone layer.

The table below should be used to help you in your response. [3]

Bond	Bond enthalpy/ kJ mol^{-1}
C—H	412
C—F	484
C—Cl	338
C—Br	276
S—F	410

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(ii) Use the information in the table in (i) above to state why sulfuryl fluoride is now preferred to bromomethane as a fumigant. [1]

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....

....

Total [12]

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Examiner only

9. *(a)* The table below shows some physical properties of six carboxylic acids.

Acid	Formula	Boiling temperature / °C	Solubility in water
ethanoic	CH_3COOH	118	solubility decreasing ↓
propanoic	CH_3CH_2COOH	141	
butanoic	$CH_3(CH_2)_2COOH$		
pentanoic	$CH_3(CH_2)_3COOH$		
hexanoic	$CH_3(CH_2)_4COOH$	205	
heptanoic	$CH_3(CH_2)_5COOH$	223	

(i) Suggest the boiling temperature of butanoic acid. [1]

....

(ii) Describe the trend in boiling temperature as the number of carbon atoms in the acids increases and suggest a reason for this effect. [3]

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(iii) Explain why the acids become less soluble in water as the sizes of the molecules increase. [2]

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Examiner only

(b) Calcium propanoate, $(CH_3CH_2COO)_2Ca$, is added to bread to prevent mould formation. It can be made from propan-1-ol by the following reactions.

$$\underset{\text{propan-1-ol}}{CH_3CH_2CH_2OH} \xrightarrow{\text{reagent(s)}} \underset{\text{propanoic acid}}{CH_3CH_2COOH} \xrightarrow{\text{calcium hydroxide}} \underset{\text{calcium propanoate}}{(CH_3CH_2COO)_2Ca}$$

(i) State the name of the reagent(s) used in the first stage. [1]

....

(ii) Propanoic acid, in its liquid state, exists as a dimer, where two molecules of the acid bond together using hydrogen bonding.

Draw the structural formula of this dimer and show the hydrogen bonding between the two molecules. [1]

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(iii) In an experiment to make calcium propanoate, 50.0 cm^3 of a solution of propanoic acid of concentration 1.00 $mol\,dm^{-3}$ was completely neutralised by calcium hydroxide.

I Calculate the number of moles of propanoic acid used. [1]

.... mol

II State the number of moles of calcium hydroxide needed to just react with all the propanoic acid. [1]

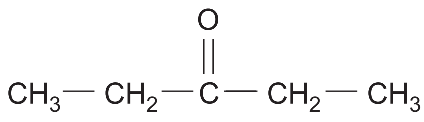
.... mol

III Calculate the maximum mass of calcium propanoate (M_r = 186) which could be formed. [1]

.... g

Examiner only

(iv) Calcium propanoate produces pentan-3-one when it is strongly heated.



pentan-3-one

Write the displayed formula of **two** structural isomers of pentan-3-one. [2]

(c) A dicarboxylic acid, HOOC—$(CH_2)_n$—COOH, contains 49.3 % of carbon and 43.8 % of oxygen by mass. In both parts (i) and (ii) **show your working**.

(i) Use these figures to find the ratio of carbon atoms to oxygen atoms in the acid. [2]

Ratio C : O ....

(ii) Use this ratio to find the value of n in the formula of the acid.
You are reminded that 1 molecule of the acid contains four oxygen atoms. [1]

n = ...

Total [16]

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Examiner only

10. *(a)* A solution of calcium chloride was obtained by adding 0.40 g of calcium metal to 80 cm^3 of hydrochloric acid of concentration 0.20 mol dm^{-3}. The equation for the reaction is

$$Ca \quad + \quad 2HCl \longrightarrow CaCl_2 \quad + \quad H_2$$

(i) Use the information given to show that an excess of calcium metal was used. [3]

(ii) State **one** observation made during the reaction apart from the mixture becoming warm. [1]

....

(b) A sample of a calcium compound **E** of mass 1.50 g was added to 200 cm^3 of cold water and the mixture heated until it all dissolved.

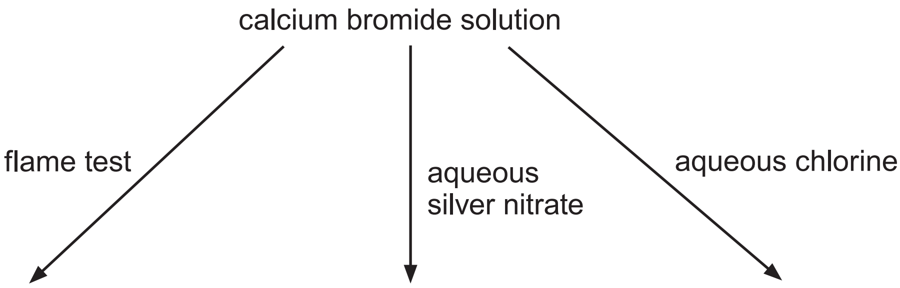
Use relevant information from the table to calculate the mass of compound **E** that crystallised when the solution was cooled to 0 °C. [2]

Solubility of compound **E** / g per 100 g of water	Temperature / °C
0.13	0
0.75	50
1.22	100

Mass that crystallised = ... g

Examiner only

(c) A student was given a solution of calcium bromide and asked to carry out the reactions shown in the diagram below.



(i) State the colour given in the flame test. [1]

....

(ii) State what was seen when aqueous silver nitrate was added. [1]

....

(iii) Give the **ionic** equation for the reaction occurring in (ii). [1]

....

(iv) State what was seen when aqueous chlorine was added to the solution of calcium bromide. [1]

....

(v) Explain why chlorine reacted as described in (iv).
Your answer should include
- the type of bonding and the species present in calcium bromide
- the type of reaction occurring
- why chlorine is able to react in this way
- an appropriate equation

[5]
QWC [1]

....

....

....

....

....

....

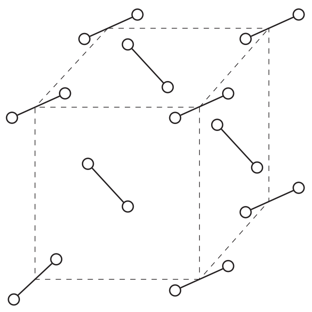
....

....

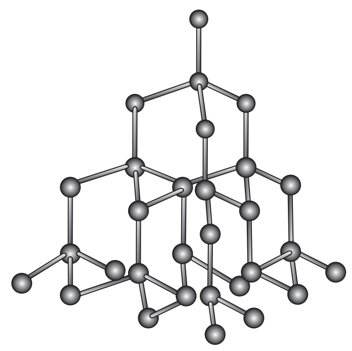
Total [16]

Examiner only

11. *(a)* The structures of solid iodine and diamond are shown below.



Iodine



Diamond

Use these diagrams to help you explain why

- iodine vapourises easily but diamond does not vapourise until about 3550 °C
- neither iodine nor diamond conduct electricity [4]

QWC [1]

....

....

....

....

....

....

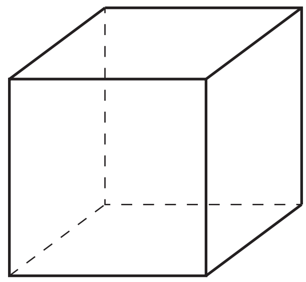
....

....

....

....

(b) Potassium iodide has the same cubic structure as sodium chloride. Use the diagram below to identify and show the positions of the species involved. [2]



(c) You are given an aqueous solution containing 0.05 mol of barium chloride and a supply of potassium sulfate solution.

Devise a method to obtain the maximum amount of pure dry barium sulfate.
You should assume that a risk assessment has been carried out. [4]
QWC [1]

....

....

....

....

....

....

....

....

Total [12]

Examiner only

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]

....

Examiner only

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

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

$$Cl_2 \longrightarrow 2Cl\bullet$$

State an essential condition for this stage. [1]

....

(ii) State what is meant by the term *propagation stage*. [1]

....

....

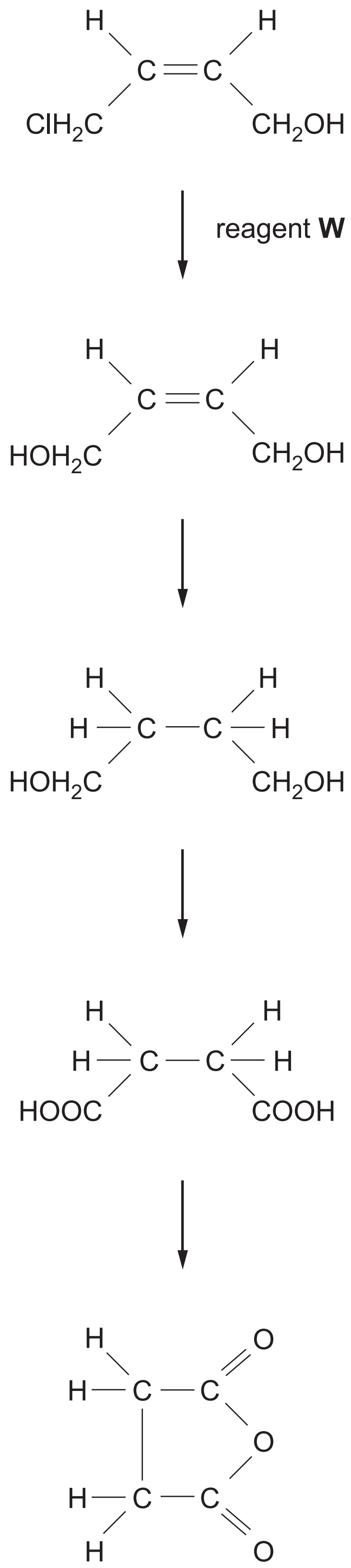
(iii) Write an equation that represents a propagation stage of this reaction. [1]

....

QUESTION CONTINUES ON PAGE 18

Examiner only

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



compound **A**

compound **B**

compound **C**

compound **D**

compound **E**

Examiner only

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

Write the displayed formula of the (*E*)-isomer of compound **A**. [1]

(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

Examiner only

For continuation only.

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

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Key: A_r (relative atomic mass) / Symbol / Name / Z (atomic number)

s Block: Groups 1–2; d Block; p Block: Groups 3–0; f Block

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ▸▸ Actinium 89															

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2014

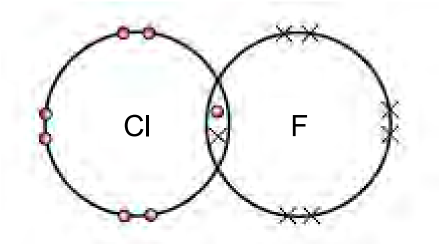
CH2

Section A

Q.1 C [1]

Q.2 (a) $Cl^{\delta+}$— $F^{\delta-}$
Electronegativity decreases down the group / fluorine is more electronegative (than chlorine) / chlorine is less electronegative (than fluorine) [1]

(b) [1]



Q.3 It has a full / stable (outer) electron shell [1]

Q.4 (a) $C_6H_{12}Br_2$ [1]

(b) Elimination [1]

Q.5 Temperature 200-300 (accept 470-570K)

Pressure 60-70 (accept 6000-7000 kPa) [1]

Q.6 Hex-2-ene (ignore references to cis/trans/*E/Z*) [1]

Q.7 (a) A process of bond breaking where the two electrons (of the covalent bond) go to one of the two atoms in the bond [1]

(b) $(CH_3)_3C^+$ and Cl^- (accept $(CH_3)_3C^-$ and Cl^+) [1]

Total Section A [10]

Section B

Q.8 (a) In SO_2 the oxidation number of sulfur is +4

In SO_2F_2 the oxidation number of sulfur is +6 (1)

Increase in (positive) oxidation number is oxidation (1) [2]

(b) The electrons in the bonds between sulfur and fluorine and sulfur and oxygen take up the position of minimum repulsion / maximum separation [1]

(c) (i) A lone pair donor / a species that seeks out a relatively positive site [1]

(ii) eg H_2O / OH^- / Cl^- (or other halogen) / CN^- / correct formula of an amine [1]

(iii) A shift of **two** electrons [1]

(d) $SO_2F_2 + 2Ca(OH)_2 \rightarrow CaSO_4 + CaF_2 + 2H_2O$

[(1) for correct formulae, (1) for balancing **if** formulae correct] [2]

(e) (i) UV radiation (1) is able to break the C—Cl and C—Br bonds (1) giving radicals (1) that attack / breakdown the ozone layer [3]

(ii) The S—F bond in sulfuryl fluoride is too strong to be broken by UV radiation [1]

Total [12]

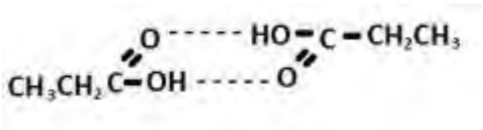
Q.9 (a) (i) 165 ± 5 °C [1]

(ii) As the number of carbon atoms in the acids increase the boiling temperature increases (1)
This is due to an increase in induced dipole-induced dipole / Van der Waals forces (1) between molecules (1) [3]

(iii) As the molecules increase in size the relative importance of the —COOH group decreases (1)
There is therefore less of a tendency to hydrogen bond **with water** (becoming less soluble) (1) [2]

(b) (i) Acidified (potassium) dichromate (accept H^+, $Cr_2O_7^{2-}$) / Acidified (potassium) manganate(VII) (accept H^+, MnO_4^-) [1]

(ii)



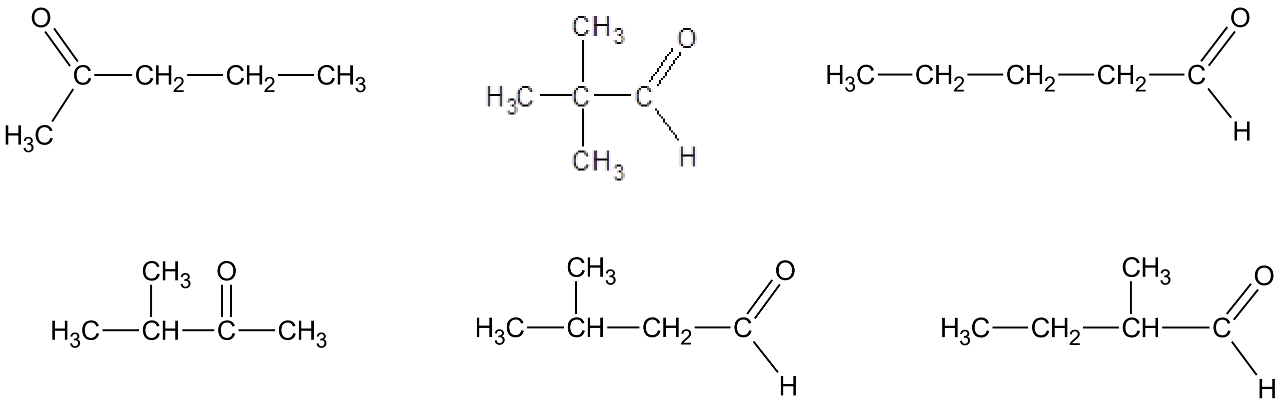
[1]

(iii) I 0.050 [1]

II 0.025 [1]

III 0.025 × 186 = 4.65 (g) [1]

(iv) Any 2 of the following:



[2]

(c) (i) $\frac{49.3}{12}$ = 4.11 $\frac{43.8}{16}$ = 2.74 (1) Ratio of C:O is 3:2 (1) [2]

(ii) There are four oxygen atoms per molecule ∴ 6 carbon atoms (and 4 oxygen atoms)

∴ n = 6 – 2 in the acid groups ∴ n = 4 [1]

Total [16]

Q.10 (a) (i) Number of moles of HCl = $\frac{80 \times 0.20}{1000}$ = 0.016 (1)

Number of moles of calcium needed = 0.008 (1)

Number of moles of calcium actually used = $\frac{0.40}{40}$ = ~ 0.010 (1)

($\therefore$ calcium is present in excess)

[Calculation could be carried out in grams] [3]

(ii) gas bubbles / effervescence / some calcium ‘dissolves’ / colourless solution produced [1]

(b) Mass of **E** in solution at 0 °C = 0.13 × 2 = 0.26 g (1)

$\therefore$ Quantity precipitated = 1.50 – 0.26 = 1.24 g (1) [2]

(c) (i) Brick red / orange-red [1]

(ii) Cream precipitate (accept off-white precipitate) [1]

(iii) $Ag^{+} + Br^{-} \rightarrow AgBr$ [1]

(iv) Red / brown solution [1]

(v) Calcium bromide is an ionic compound (1)
and contains Ca^{2+} and Br^{-} ions (1)
Chlorine reacts with the bromide ions in a redox / displacement reaction (1)
Chlorine is a more powerful oxidising agent / has a greater affinity for electrons than bromine (1)
$2Br^{-} + Cl_2 \rightarrow Br_2 + 2Cl^{-}$ (1) [5]

QWC: ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear [1]

Total [16]

Q.11 (a) Iodine contains weak van der Waals forces / bonds between each molecule (1)
Less energy is needed to overcome these weaker forces (1) *
Diamond contains strong covalent bonds between each atom (1)
and more energy is needed to overcome these 'bonds' (1) *
* alternative marks

Neither iodine nor diamond contain free / delocalised electrons to carry the charge (necessary for them to conduct electricity) (1) [4]

QWC: organise information clearly and coherently, using specialist vocabulary when appropriate [1]

(b) K^+ and I^- correctly given (1) and in their correct places on the diagram (1) [2]

(c) An excess / stoichiometric / 0.05 mol (1) of potassium sulfate (aq) is added to the barium chloride solution
Mixture is stirred (1) * and then filtered (1)
Precipitated barium sulfate is then washed with distilled water (1)
and dried (1) * [4]
* alternative marks

QWC: Select and use a form and style of writing appropriate to purpose and to complex subject matter [1]

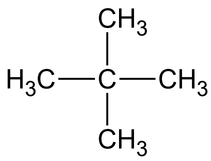
Total [12]

Q.12 (a) (i) Petroleum is heated/evaporated (1)
Fractions condense at different temperatures / separated into fractions with different boiling temperatures (1)

[2]

(ii) C_5H_{12} (1)

Branched chain therefore



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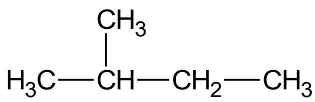


(1)

[2]

(b) (i) It enables more useful compounds to be made from the compound [1]

(ii) $C_9H_{20} \rightarrow CH_4 + C_4H_6 + C_4H_{10}$ [1]

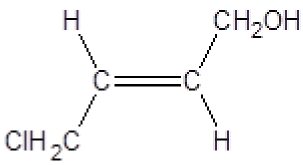
(c) (i) UV light [1]

(ii) A step during which a radical reacts and another one is formed [1]

(iii) $Cl\bullet + CH_4 \rightarrow \bullet CH_3 + HCl$

[or $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$] [1]

(d) (i)



[1]

(ii) Aqueous sodium hydroxide [1]

(iii) Pt / N / Pd [1]

(iv) Compound **E** does not contain an O—H bond (1)
This is present in Compound **D** at a frequency of 2500-3550 cm^{-1} (1)

[2]

Total [14]

Total Section B [70]

Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1092/01 **New AS**

CHEMISTRY CH2

A.M. WEDNESDAY, 3 June 2009

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-4	
B	5	
	6	
	7	
	8	
	9	
TOTAL MARK		

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 15 may be used for rough work.

Examiner only

SECTION A

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

1. Complete the table below by putting a tick (✓) in the boxes that correctly describe graphite. [1]

Conducts electricity		*Melting temperature*		*Bonding*	
Yes	No	High	Low	Covalent	Ionic

2. (i) Give the equation for the reaction of barium metal with water. [1]

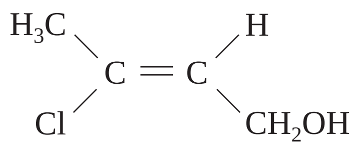
....

(ii) The solution obtained in (i) contains barium ions.
State a reagent that would be added to this solution to show the presence of barium ions, giving the result of the test.

Reagent .... [1]

Observation .... [1]

3. (i) Explain why Compound **T** has E-Z (trans-cis) isomers. [1]

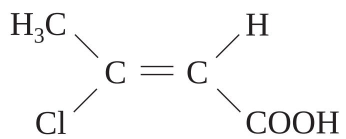


Compound **T**

....

....

(ii) State a reagent, used in acid solution, that reacts with Compound **T** to give Compound **Y**. [1]



Compound **Y**

....

(iii) State the **type** of reaction occurring in part (ii). [1]

....

(iv) The empirical formula of a substance is $C_4H_5ClO_2$.
State what additional information is needed so that its molecular formula can be found. [1]

....

4. There is continued debate about the safety of adding fluoride ions to drinking water.

(i) Give the **ionic** half equation for the formation of fluoride ions from fluorine gas. [1]

....

(ii) Explain why there is a strong tendency for fluorine to form fluoride ions. [1]

....

....

Section A Total [10]

SECTION B

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

5. *(a)* The Solvay process is used to make sodium compounds from sodium chloride.

(i) The first step in the process requires ammonia, which can be made by reacting ammonium chloride with calcium hydroxide, as shown in the equation below.

	$2NH_4Cl$	$+ \ Ca(OH)_2$	$\longrightarrow$	$CaCl_2$	$+ \ 2H_2O$	$+ \ 2NH_3$
molar masses	2×53.5 g	74 g		111 g	2×18 g	2×17 g

Calculate the atom economy of this reaction where ammonia is the required product.

$$\text{atom economy} = \frac{\text{theoretical mass of required products} \times 100}{\text{total mass of reactants used}} \ \%$$ [2]

....

....

(ii) A disadvantage of the Solvay process is that the chloride ions from the sodium chloride are converted into calcium chloride, for which there has been little demand. However, recently, concentrated aqueous solutions of calcium chloride have been used in the oil industry.
A typical solution contains 45 g of calcium chloride in 100 cm^3 of solution.
Use the molar mass of calcium chloride, given in (i), to calculate the concentration of this solution in mol dm^{-3}. [2]

....

....

.... mol dm^{-3}

(iii) Give the equation for the reaction of calcium metal with hydrochloric acid to give calcium chloride as one of the products. [1]

....

(iv) Calcium ions can be identified in a solution of calcium chloride by a flame test.
State the colour of the flame obtained. [1]

....

Examiner only

(v) Describe how you would test for the presence of chloride ions in a solution of calcium chloride, giving the reagent used and an observation.

Reagent .... [1]

Observation .... [1]

(vi) Calcium chloride is an ionic compound.
Draw a dot and cross diagram for this compound, showing the outer electrons for both calcium and chlorine atoms, the outer electrons for each ion and any charges produced. [2]

(vii) Anhydrous calcium chloride, $CaCl_2$, can be used as a drying agent for some organic liquids. During this process, hydrated calcium chloride, $CaCl_2.\ 2H_2O$, is formed.

$$CaCl_2(s) \quad + \quad 2H_2O \longrightarrow CaCl_2.2H_2O$$

M_r 111

In a drying process, 5.55 g of anhydrous calcium chloride, $CaCl_2$, was used.
Calculate how much water can be removed from the organic liquid. [2]

....

....

....

(viii) Calcium chloride is unsuitable for drying ethanol as the ethanol bonds to the calcium chloride using a co-ordinate bond.

State what is meant by the term **co-ordinate** bond. [1]

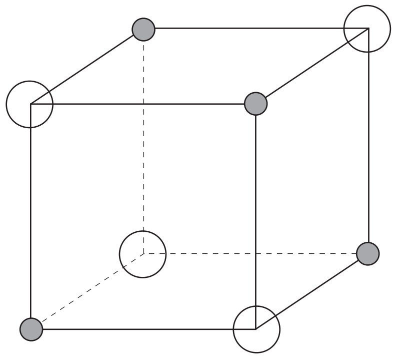
....

....

Total [13]

Examiner only

6. *(a)* The following diagram shows the crystal structure of sodium chloride.



(i) Write the formula of the species represented as

● .... , ○ .... [1]

(ii) State the crystal co-ordination numbers for sodium chloride. .... [1]

(iii) State the crystal co-ordination numbers for caesium chloride and explain why these are different from those of sodium chloride. [2]

....

....

(b) (i) Explain why sodium chloride is soluble in water. [2]

....

....

....

(ii) A student was finding the solubility of sodium chloride in water.
He heated a saturated solution of sodium chloride to dryness, using an evaporating basin.
The following table of results was obtained.

Mass of evaporating basin + sodium chloride solution	=	140.57 g
Mass of evaporating basin	=	72.00 g
∴ Mass of sodium chloride solution	=	.... g
Mass of evaporating basin + dry sodium chloride	=	90.57 g
Mass of evaporating basin	=	72.00 g
∴ Mass of dry sodium chloride	=	.... g

I. Calculate and record the missing values in the table of results. [1]

II. State the mass of water in the sodium chloride solution .... g [1]

III. Calculate the solubility of sodium chloride in water in g / 100 g of water.

....

....

Solubility = ... g / 100 g water [1]

IV. State what should have been recorded so that the solubility obtained can be compared against known values. [1]

....

(c) State why sodium is described as an s-block element. [1]

....

(d) Titanium metal is obtained by heating titanium(IV) chloride with sodium.

$$4Na + TiCl_4 \longrightarrow Ti + 4NaCl$$

State the oxidation number (state) of each element present and use these to explain which species has been oxidised in this reaction. [2]

....

....

Total [13]

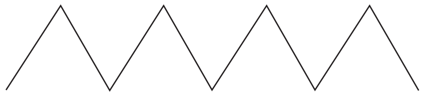
Examiner only

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]

....

....

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



Give the molecular formula of this hydrocarbon. [1]

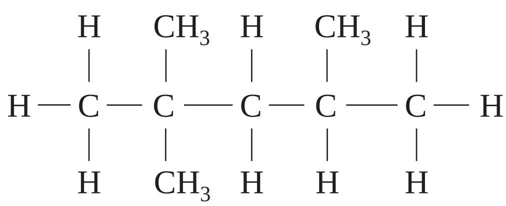
....

(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]

....

....

(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, CH_2Cl_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}Cl atoms in each molecule.
Suggest a molecular formula and a displayed (structural) formula for this compound, explaining how it might be formed. [3]

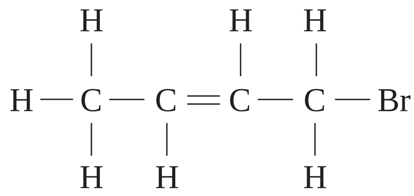
....

....

....

Total [15]

8. *(a)* As part of a project, two students were asked to report on tests for functional groups present in the compound below.



Nia reported that, in testing for the C ═ C group,

- aqueous bromine should be added to the compound and
  if the test is positive, the colour of the mixture changes from purple to colourless;
- the name of the compound formed in this test is 2, 3, 4-tribromobutane.

(i) Correct the two mistakes in her report.

I. .... [1]

II. .... [1]

David reported that, in testing for the >C — Br group,

- dilute hydrochloric acid should be added to the compound;
- aqueous silver nitrate should then be added;
- you should then see a cream precipitate that dissolves completely in dilute aqueous ammonia.

(ii) I. State what chemical should be added before adding any acid. [1]

....

II. Why is it wrong to use dilute hydrochloric acid? [1]

....

....

III. State the error in the third statement. [1]

....

(b) 1-Bromobut-2-ene can be made from but-2-en-1-ol.

$$H_3C - CH = CH - CH_2OH \longrightarrow H_3C - CH = CH - CH_2Br$$

	but-2-en-1-ol	1-bromobut-2-ene
boiling temperatures / °C	121	98

(i) Use the infrared absorption frequencies given in the **Data Sheet** to explain how you would know if a sample of 1-bromobut-2-ene contains unreacted but-2-en-1-ol. [2]

....

....

....

(ii) Use your understanding of intermolecular forces to explain why but-2-en-1-ol has a higher boiling temperature than 1-bromobut-2-ene.
Your answer should include:
- a description of **all** the intermolecular forces present for each compound;
- the relative strengths of the intermolecular forces present. [6]

(QWC) [2]

....

....

....

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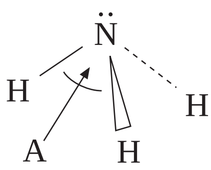
....

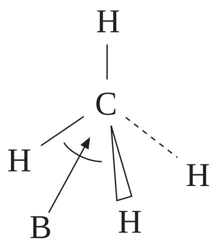
....

Total [15]

Examiner only

9. *(a)* (i) Explain why angle **A** in an ammonia molecule is less than angle **B** in a methane molecule. [1]





....

....

(ii) A student wrote that *'the bonds in an ammonia molecule are not purely covalent'*. Explain why this statement is correct. [2]

....

....

(b) The d-block element, nickel, has a number of important uses.

(i) Nickel is used as the catalyst in the hydrogenation of alkenes. Using an alkene of your choice, write an equation, using displayed formulae, for this hydrogenation, naming your product. [2]

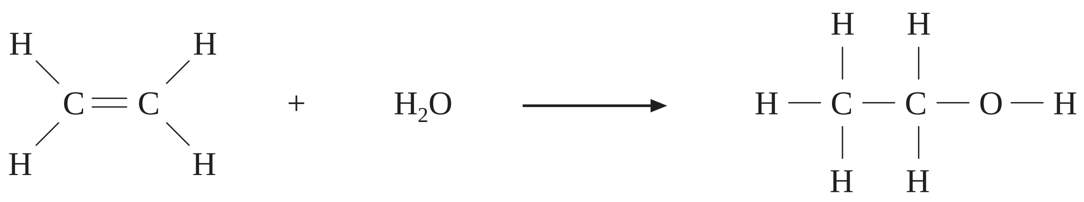
(ii) In recent years, nickel-containing 'smart alloys' have been developed. A particular smart alloy changes shape when a force is applied but returns to its original shape when the force is removed. Suggest a use for this type of smart alloy. [1]

....

(iii) Nickel is purified using nickel tetracarbonyl, $Ni(CO)_4$. This is a tetrahedral molecule with the same shape as methane.

State the bond angle in such tetrahedral molecules. .... [1]

(c) The industrial preparation of ethanol from ethene is carried out at 300 °C in the presence of a catalyst.



(i) State the pressure used in this process .... [1]

(ii) The **reverse** process is carried out by passing ethanol vapour over a catalyst.

I. State a catalyst that can be used .... [1]

II. State the type of reaction that is occurring in this **reverse** process. [1]

....

(d) (i) 1, 1, 1-Trifluoro-2-bromo-2-chloroethane (halothane) is used as a general anaesthetic. Write the displayed formula for this compound. [1]

(ii) State another use for halogenoalkanes. [1]

....

(iii) One disadvantage of some halogenoalkanes, the CFCs, is that they cause damage to the ozone layer.
The table shows the relative ozone depletion potential (RODP) of some CFCs, taking CCl_3F as having a value of 1.0.

Compound	RODP
CHF_3	0.01
$CHC1F_2$	0.05
CCl_2F_2	0.86
CCl_3F	1.00
$CBrClF_2$	10.00

The carbon-halogen bond energies are shown below.

Bond	*Average bond enthalpy* / kJ mol^{-1}
C—Br	276
C—Cl	338
C—F	484

Use both tables to comment on how the C—halogen bond energies, and the number and type of halogen atoms per molecule, are related to their destructive effects on the ozone layer. [2]

....

....

....

....

Total [14]

Section B Total [70]

Examiner only

Rough Work

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CBAC

MS4
£4.00

GCE MARKING SCHEME

CHEMISTRY (NEW)
AS/Advanced

SUMMER 2009

CH2

Section A

1.

Conducts electricity		Melting temperature		Bonding	
Yes	No	High	Low	Covalent	Ionic
✓		✓		✓	

[1]

2. (i) Ba + 2 H_2O → $Ba(OH)_2$ + H_2 [1]

(ii) Reagent: e.g. sulfuric acid [1]

Observation: white precipitate [1]

3. (i) There is no free rotation **about a double bond** / the compound has two different groups either side of the double bond [1]

(ii) potassium dichromate(VI) / $K_2Cr_2O_7$ / dichromate / $Cr_2O_7^{2-}$ [1]

(iii) oxidation / redox [1]

(iv) (relative) molecular mass / molar mass [1]

4. (i) F_2 + 2 e^- → 2 F^- [1]

(ii) (A) fluorine (atom) needs to gain an electron to have a full (outer) shell / fluorine has a high electronegativity [1]

Section A Total [10]

Section B

5. *(a)* (i) atom economy = $\dfrac{34 \times 100}{(2 \times 53.5) + 74}$ (1) = 19 (1) [2]

(ii) 45 g / 100 cm^3 ≡ 450 g dm^{-3} (1)

concentration = $\dfrac{450}{111}$ = 4.05 (accept 4.1) mol dm^{-3} (1) [2]

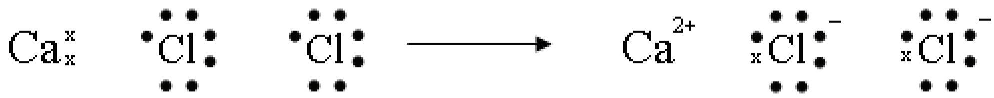
(iii) $Ca + 2HCl \rightarrow CaCl_2 + H_2$ [1]

(iv) orange-red / brick red [1]

(v) Reagent: silver nitrate / $AgNO_3$ / Ag^+ / silver ions [1]

Observation: white precipitate [1]

(vi)



left hand side correct (1) right hand side correct (1) [2]

(vii) 111g of calcium chloride removes / react with 2 ×18.0 g water (1)

∴ 5.55 g of calcium chloride mass removes / reacts with = $\dfrac{5.55 \times 2 \times 18.0}{111}$

= 1.80 (g) (1)

or in moles:

moles of calcium chloride 0.05 (1) moles of water 0.10 (1)

[2]

(viii) a covalent bond where one of the atoms (of the bond) provides both electrons [1]

Total [13]

6. *(a)* (i) ● Na^+ ○ Cl^- [1]

(ii) 6 : 6 [1]

(iii) 8 : 8 (1)

Cs^+ ion / cation is much larger than the Cl^- ion / anion (1)

[2]

(b) (i) Na^+ ions are attracted to (δ-) oxygen of water molecules (1)

Cl^- ions are attracted to (δ+) hydrogen of water molecules (1) [2]

(ii) I

	Mass of evaporating basin + sodium chloride solution	=	140.57 g
	Mass of evaporating basin	=	72.00 g
∴	Mass of sodium chloride solution	=	68.57 g
	Mass of evaporating basin + dry sodium chloride	=	90.57 g
	Mass of evaporating basin	=	72.00 g
∴	Mass of dry sodium chloride	=	18.57 g

[1]

II 50.00 g [1]

III 2 × 18.57 = 37.14 g / 100 g water [1]

IV temperature [1]

(c) the **outer** electron of an atom is an s electron [1]

(d)

$$4\,Na \;+\; TiCl_4 \;\rightarrow\; Ti \;+\; 4\,NaCl$$

0 +4 (-1 x 4) 0 4 (+1) 4(-1) (1)

sodium has increased its oxidation number i.e. oxidation (1) [2]

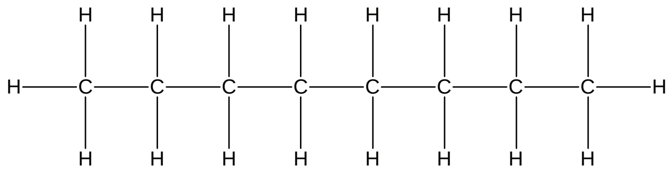
Total [13]

7. *(a)* (i) Separation of the alkanes by differences in their boiling temperatures [1]

(ii) C_9H_{20} [1]

(iii) Breaking of larger (alkane) molecules into smaller molecules (1) which are more useful / in relative short supply (1) [2]

(iv)



[1]

(b) (i) The chlorine molecule is split by UV light (1) by homolytic fission (1) giving two chlorine free radicals

$Cl_2 \rightarrow 2\,Cl\bullet$ (1)

In the propagation stage radicals react to produce new radicals

$CH_3Cl + Cl\bullet \rightarrow \bullet CH_2Cl + HCl$ (1)

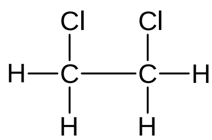
$\bullet CH_2Cl + Cl_2 \rightarrow CH_2Cl_2 + Cl\bullet$ (1)

In the termination stage two radicals combine giving dichloromethane

$\bullet CH_2Cl + Cl\bullet \rightarrow CH_2Cl_2$ (1) [6]

(QWC) *organise information clearly and coherently, using specialist vocabulary when appropriate* [1]

(ii) $C_2H_4Cl_2$ (1) displayed formula is



(accept the displayed formula of 1,1-dichloroethane) (1)

formed by the reaction together of two $\bullet CH_2Cl$ radicals (1)

[3]

Total [15]

8. *(a)* (i) I the colour changes from red/brown/orange to colourless [1]

II the name of the compound is 1,2,3-tribromobutane / 1,3-dibromobutan-2-ol / 1,2-dibromobutan-3-ol [1]

(ii) I (warm) with (aqueous) sodium hydroxide / NaOH / alkaline solution [1]

II this would give a white precipitate with aqueous silver nitrate / a source of chloride ions [1]

III the precipitate is not completely soluble in dilute aqueous ammonia / the precipitate is soluble in concentrated aqueous ammonia [1]

(b) (i) The sample would give a (broad) signal at 2500 – 3550 cm^{-1} (1)
characteristic of the O–H bond (1)
accept answers based on C–O [2]

(ii) Both molecules possess van der Waals forces (1)
Both molecules possess dipole-dipole forces (1) e.g. $C^{\delta+}$– $Br^{\delta-}$ or $C^{\delta+}$– $OH^{\delta-}$ (1)
But-2-en-1-ol has hydrogen bonding and the bromo compound does not (1)
Hydrogen bonding is stronger than other intermolecular forces (1)
therefore more energy is needed to separate the molecules (1)
[6]

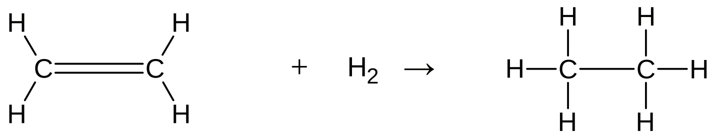
(QWC) *Ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear* [1]
Select and use a form and style of writing appropriate to purpose and to complex subject matter [1]

Total [15]

9. *(a)* (i) lone pair / bonding pair repulsion is greater than bonding pair / bonding pair repulsion [1]

(ii) nitrogen and hydrogen have different electronegativities (1) and this results in polarity / unequal electron distribution in the bond (1) [2]

(b) (i) e.g.



equation using displayed formulae (1)

ethane named (1) [2]

(ii) e.g. spectacle frames / teeth brace [1]

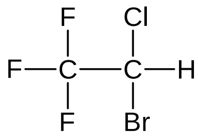
(iii) 109^{o} 28’ / 109½° / 109° [1]

(c) (i) 60 – 70 atmospheres [1]

(ii) I e.g. Al_2O_3 / porous pot / concentrated sulphuric acid / concentrated phosphoric acid [1]

II elimination / dehydration [1]

(d) (i)



[1]

(ii) e.g. refrigerants / dry cleaning / solvents / pesticides / polymers [1]

(iii) Any TWO from:

the C – Br bond is the weakest and this has the greatest effect on the ozone layer, seen in $CHClF_2$ (0.05) and $CBrClF_2$ (10) (1)

increasing numbers of C – Cl bonds increase the RODP effect (1)

there is a marked increase in effect when going from 1 chlorine atom in a molecule to 2 chlorine atoms (1)

there is not such a marked change in effect when going from 2 chlorine atoms in a molecule to 3 chlorine atoms (1)

the C – F bond is the strongest and does not cause destruction of the ozone layer / has little effect on the ozone layer (1)

[2]

Total [14]

Section B Total [70]

Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1092/01

CHEMISTRY CH2

A.M. MONDAY, 7 June 2010

$1\frac{1}{2}$ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
	11	
TOTAL MARK		

1092 01 01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

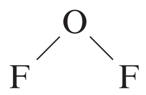
Page 14 may be used for rough work.

Examiner only

SECTION A

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

1. The covalent compound difluorine oxide has the formula



(i) Showing **outer** electrons only, draw a dot and cross diagram for difluorine oxide. [1]

(ii) Difluorine oxide reacts with magnesium metal to produce magnesium oxide and magnesium fluoride, MgF_2.
Give the equation for this reaction. [1]

....

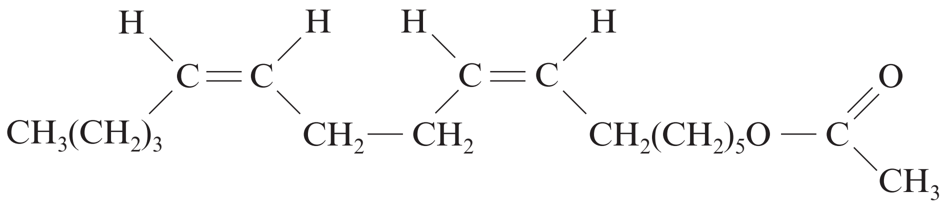
2. Potassium chloride can be used by those who need a low-salt diet.
Its solubility in water at two temperatures is shown in the table.

Temperature / °C	Solubility / g per 100 g of water
15	32.7
100	56.5

Calculate the mass of solid potassium chloride produced when a saturated solution containing 500 g of water is cooled from 100 °C to 15 °C. [2]

.... g

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



(i) State a suitable catalyst for the hydrogenation of the $\rangle C{=}C\langle$ bonds present. [1]

....

(ii) This pheromone molecule contains two $\rangle C{=}C\langle$ 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 C_nH_{2n+2}.

(i) State the **molecular** formula of the alkane. .... [1]

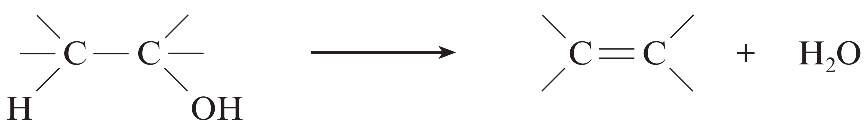
(ii) Draw one **displayed** formula of this alkane. [1]

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]

SECTION B

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

7. *(a)* Sulfur hexafluoride, SF_6, is a colourless gas that is used as an insulator in electrical transformers.

(i) Complete the table below, giving the number of bonding and lone pairs for the sulfur atom in a molecule of gaseous sulfur hexafluoride.

Use your answers to deduce an $F — \hat{S} — F$ angle and name the shape of the SF_6 molecule. [4]

Number of bonding pairs	Number of lone pairs	$F — \hat{S} — F$	Shape

(ii) The S — F bond in sulfur hexafluoride is a polar covalent bond.
Describe what is meant by bond polarity and how it arises in this bond. [2]

....

....

....

(iii) Sulfur hexafluoride reacts with hydrogen sulfide in a redox reaction.

$$SF_6 \quad + \quad 3H_2S \longrightarrow 6HF \quad + \quad 4S$$

Complete the table below, giving the oxidation states (numbers) of the sulfur atoms present and use these to explain how hydrogen sulfide is the reducing agent in this reaction. [2]

Oxidation state of sulfur in SF_6	Oxidation state of sulfur in H_2S	Oxidation state of sulfur in sulfur, S

....

....

....

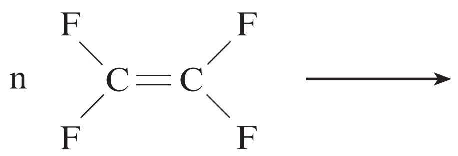
(b) Sodium fluoride is a white, ionic solid that has the same crystal structure as sodium chloride.
Give the formula of each ion present and its crystal co-ordination number. [2]

Sodium ion .... *Crystal co-ordination number* ....

Fluoride ion .... *Crystal co-ordination number* ....

(c) Tetrafluoroethene, C_2F_4, can be polymerised to give poly(tetrafluoroethene), PTFE, in a similar way to the polymerisation of ethene.

(i) Complete and balance the equation below, showing a repeating section of the structural formula of poly(tetrafluoroethene). [1]



(ii) A stretched form of PTFE is marketed under the name ‘Goretex’. This is used to make waterproof materials that can ‘breathe’. Gaseous water molecules can escape from tiny ‘holes’ in the fabric but larger liquid water droplets cannot enter. These liquid water droplets contain water molecules that are hydrogen bonded to each other.

Draw a diagram to show hydrogen bonding between water molecules. [3]

Total [14]

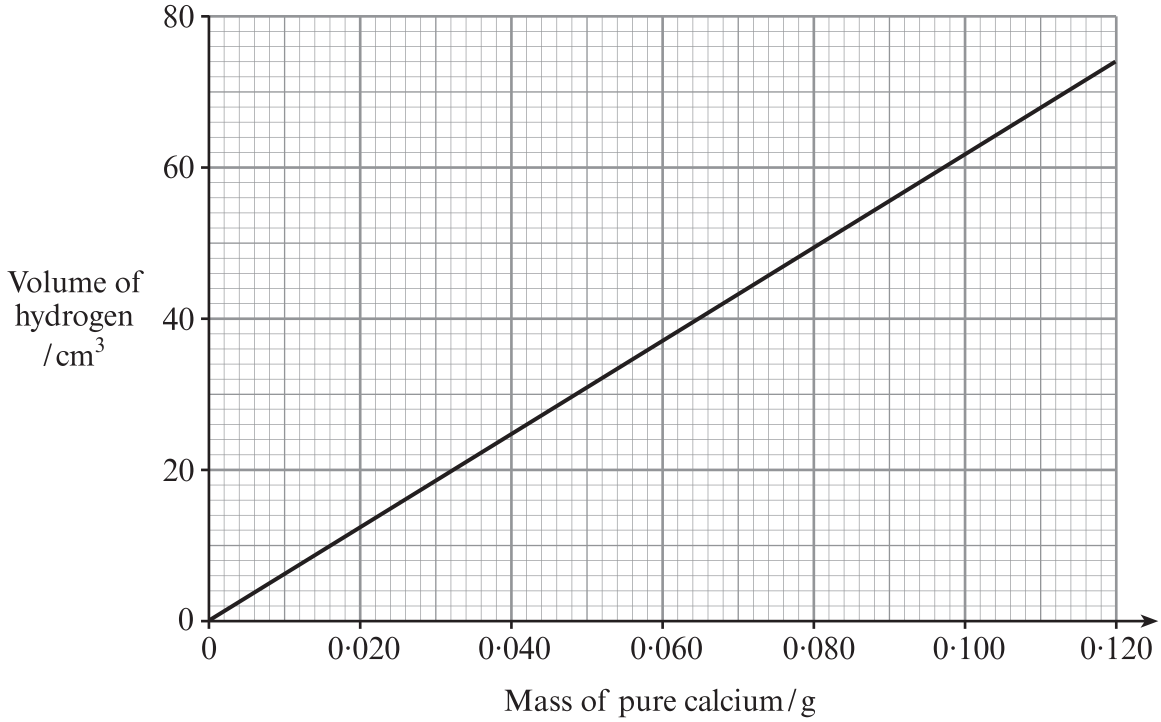
1092 01 05

Examiner only

8. *(a)* (i) 0.115 g of impure calcium metal was added to water. Hydrogen gas and calcium hydroxide were formed.
Give the equation for this reaction. [1]

....

(ii) All the hydrogen produced was collected and gave a volume of 64.0 cm^3.



Use the graph to find the mass of pure calcium present and hence the percentage purity of the calcium used. [2]

....

....

(iii) Jonathan added a piece of strontium metal to water. He noticed that the reaction was more vigorous than when using calcium. He said that one reason for this was that the strontium ion, Sr^{2+}, was formed more easily than the calcium ion, Ca^{2+}.

Explain why this statement is true, in terms of the electronic structures of the two metals. [2]

....

....

....

Examiner only

(b) A solution, giving an apple-green colour to a flame, was suspected to be aqueous barium hydroxide.

Describe **two** simple tests to confirm this conclusion, giving the result of each test. [2]

1. ....

....

2. ....

....

(c) Both solid strontium metal and solid graphite are conductors of electricity.
Describe the structures of these two materials and explain how they are both able to conduct electricity. You may use diagrams in your answer. [5]

QWC [1]

Strontium

....

....

Graphite

....

....

(d) There is much interest in carbon nanotubes as drug delivery agents.
Describe how the structure of carbon nanotubes is related to the structure of graphite. [2]

....

....

....

Total [15]

1092 01 07

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

$$CH_4(g) \quad + \quad Cl_2(g) \longrightarrow CH_3Cl(g) \quad + \quad HCl(g)$$

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]

....

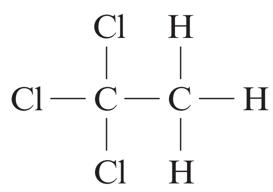
....

(ii) a propagation stage. [2]

....

....

(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]

....

....

....

Examiner only

(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 $1725\,cm^{-1}$ and $2500 - 3500\,cm^{-1}$.
Use this information, showing your working, to suggest a structural formula for liquid **R**. [4]

....

....

....

....

....

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]

10. *(a)* Bromine is produced commercially from bromide ions in sea water by reaction with chlorine.

(i) Give the equation for this reaction. [1]

....

(ii) Although both bromine and chlorine are oxidising agents, this reaction proceeds because chlorine is a stronger oxidising agent than bromine.

I. Explain what is meant by the term *oxidising agent*. [1]

....

....

II. Explain why chlorine is the stronger oxidising agent. [2]

....

....

(iii) Air is then blown through the bromine-containing mixture to remove bromine as its vapour.
Iodine can be produced in a similar way from the iodide ions present in sea water but it is more difficult to produce iodine vapour from its solution because iodine is less volatile than bromine.
Explain, in terms of bonding, why iodine is less volatile than bromine. [2]

....

....

....

(b) One important use of a bromine compound is as a very concentrated aqueous solution of calcium bromide, in the oil industry.

(i) The concentration of a calcium bromide solution is $1200\,g\,dm^{-3}$.
Calculate the concentration of this solution in $mol\,dm^{-3}$. [2]

....

....

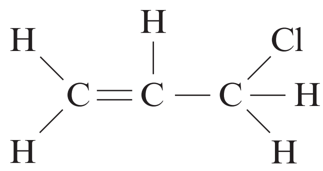
(ii) Many of the metals present in compounds of Group 2 can be identified by a flame test.
Complete the table below showing the flame colours (if any) obtained using magnesium bromide and calcium bromide. [2]

Compound	Flame colour (if any)
magnesium bromide	
calcium bromide	

(c) 1,2-Dibromo-3-chloropropane has been used to control nematode worm attack on fruit and vegetables.

(i) Give the displayed formula of this compound. [1]

(ii) It can be made by reacting 3-chloropropene with bromine.



3-chloropropene

I. State why this is described as an addition reaction. [1]

....

....

II. Bromine reacts as an electrophile in this reaction.
Give the **formula** of another example of an electrophile. [1]

....

III. The mechanism for this reaction can be shown using a curly arrow (↷).
State what this symbol is used to represent. [1]

....

Total [14]

11. *(a)* One method for making butan-1-ol is to react sodium hydroxide (used as a source of hydroxide ions) and 1-chlorobutane.
Describe how butan-1-ol can be made in this way.
Your answer should
- state any necessary conditions
- show the mechanism for the reaction between hydroxide ions and 1-chlorobutane
- state the type of reaction mechanism [6]

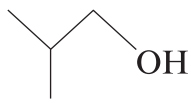
(QWC) [2]

....

....

....

(b) Compound **G** is an isomer of butan-l-ol and its skeletal formula is



(i) Give the **systematic name** of compound **G**. [1]

....

(ii) Compound **G**, $C_4H_{10}O$, is being developed as a possible replacement for ethanol in fuels. In a new process it is made by reacting genetically modified *E. coli* bacteria with glucose in aqueous solution.
One equation for this is

$$C_6H_{12}O_6 \longrightarrow \underset{M_r\ 74}{C_4H_{10}O} + 2CO_2 + H_2O$$

In a laboratory experiment, 0.50 mol of glucose reacted in this way to give an 86% yield, by mass, of compound **G**.
Calculate the mass of compound **G** produced. [2]

....

....

....

Examiner only

(iii) Both butan-1-ol and compound **G** are primary alcohols that can be oxidised to carboxylic acids.
Give an oxidising agent that can be used, in acid solution, to oxidise primary alcohols to carboxylic acids and state what is seen as the reaction proceeds. [2]

Oxidising agent ....

Observation(s) ....

(c) One method of preparing an alcohol is from an alkene and water/steam.
State the conditions of temperature and pressure used in the preparation of ethanol from ethene. [2]

Temperature ....

Pressure ....

Total [15]

Total Section B [70]

Examiner only

Rough Work

GCE MARKING SCHEME

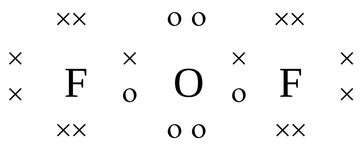
CHEMISTRY
AS/Advanced

SUMMER 2010

CH2

SECTION A

1. (i)



[1]

all outer electrons must be shown.

(ii) $F_2O + 2Mg \rightarrow MgO + MgF_2$ [1]

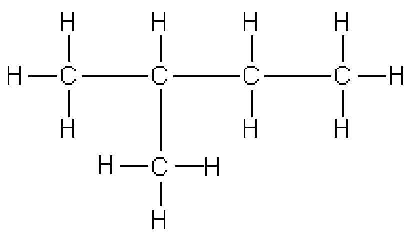
2. 23.8 g produced per 100 g of water (1)
5 × 23.8 g produced per 500 g of water = 119 (g) (1) [2]

3. (i) Ni / Pt /Pd [1]

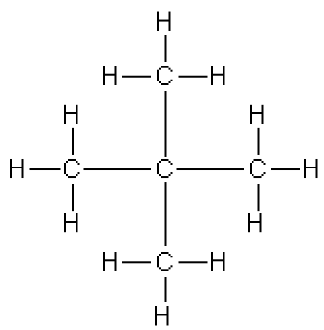
(ii) eg because of restricted/no rotation about the double bond [1]

4. (i) C_5H_{12} [1]

(ii)



or



[1]

5. ………. increases………. …………………… decreases. [1]

6. elimination / dehydration [1]

Section A Total [10]

SECTION B

7. (a) (i)

Number of bonding pairs	Number of lone pairs	F – S – F	Shape
6	0	90° / 180°	octahedral

one mark for each correct answer [4]

(ii) There is an unequal electron distribution in the bond (1) because fluorine has a higher electronegativity (in this bond) (1) (accept a diagram) [2]

(iii)

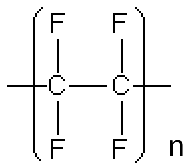
Oxidation state of sulfur in SF_6	Oxidation state of sulfur in H_2S	Oxidation state of sulfur in sulfur, S
(+)6	–2	0

(1)

The sulfur atom in sulfur hexafluoride has become less positive / more negative
∴ reduced by reaction with hydrogen sulfide (1) [2]

(b) Na^+ F^- correct formula of both ions (1)
6 : 6 (1) [2]

(c) (i)

→  [1]

(ii) diagram shows correct δ^+ / δ^- (1) correct lone pairs (1)
intermolecular bonding correct (1) [3]

Total [14]

8. (a) (i) $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ [1]

(ii) from the graph the mass of pure calcium = 0.104 g (1)

% purity of calcium = $\frac{0.104 \times 100}{0.115}$ = 90.4 (1) [2]

(iii) The (2) outer electrons to be removed are further from the nucleus in a strontium atom/strontium atom is larger/has an extra shell of electrons (1)
There is less electron shielding in the calcium atom / more electron shielding in the strontium atom (1) [2]

(b) addition of a sulfate (ion) / sulfuric acid – white precipitate (1)
addition of an acid-base indicator / pH probe – solution is basic / pH > 7 (1) [2]

(c) strontium
writing / diagram indicates lattice of cations with 'sea' of electrons (1)
electrons able to move (under applied potential), carry charge (1)

graphite
diagram shows hexagonal layer structure (1)
weak intermolecular/Van der Waals forces between layers (1)
(Delocalised) electrons able to move / carry charge (under applied potential) (1) [5]

QWC ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear [1]

(d) nanotubes consist of layers / pipelines of graphite hexagons (1)
closed at the end by (pentagons of) carbon atoms / OWTTE (1) [2]

Total [15]

9. (a) (i) Homolytic fission – a process of **covalent** bond breaking where each atom (of the bond) receives an electron (from the bond) (1)

$Cl – Cl \rightarrow 2\,Cl\bullet$ (1) [2]

(ii) Propagation stage – a stage where a (free) radical reacts and another is generated (to carry on the reaction) (1)

eg $Cl\bullet + CH_4 \rightarrow \bullet CH_3 + HCl$ (1) [2]

(b) (i) The C – F bond is stronger than the C – Cl bond (1)
and is not broken by **UV** radiation (1) [2]

(ii) I m/e 60 $\rightarrow$ M_r 60 (1)
1725 cm^{-1} $\rightarrow$ C = O (1)
2500-3500 cm^{-1} $\rightarrow$ O – H (1)
likely to be ethanoic acid (1) (accept 2-hydroxyethanal) [4]

II Reagent – silver nitrate / $AgNO_3$ / silver ions / Ag^+ (assume aqueous) (1)
White precipitate (1) [2]

Total [12]

10. (a) (i) $2Br^{-}$ + Cl_2 $\rightarrow$ Br_2 + $2Cl^{-}$ [1]
accept stoichiometric equation, e.g. using NaBr (not HBr)

(ii) I An oxidising agent is itself reduced / gains electrons / removes electrons from the other reactant. [1]

II In this reaction the outer electron shell of a chlorine atom is closer to the nucleus than in a bromine atom / chlorine is a smaller atom (1) and therefore the attraction for the electron is greater (1) [2]

(iii) Iodine is a bigger molecule / contains more electrons (or vice versa) (1) therefore intermolecular Van der Waals forces are greater for iodine (1), (more energy is needed to separate iodine molecules, therefore less volatile than bromine) [2]

(unqualified mention of Van der Waals forces (1))

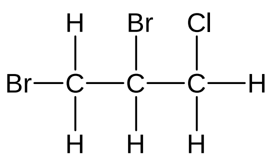
(b) (i) M_r of calcium bromide $\rightarrow$ 200 / 199.9 (1)
Concentration = $\frac{\text{no. of moles}}{\text{volume}}$ = 1200 / 200 $\div$ 1 = 6 (mol dm^{-3}) (1) [2]

(ii)

Compound	*Flame colour(if any)*
magnesium bromide	none (1)
calcium bromide	brick red (1)

[2]

(c) (i)



[1]

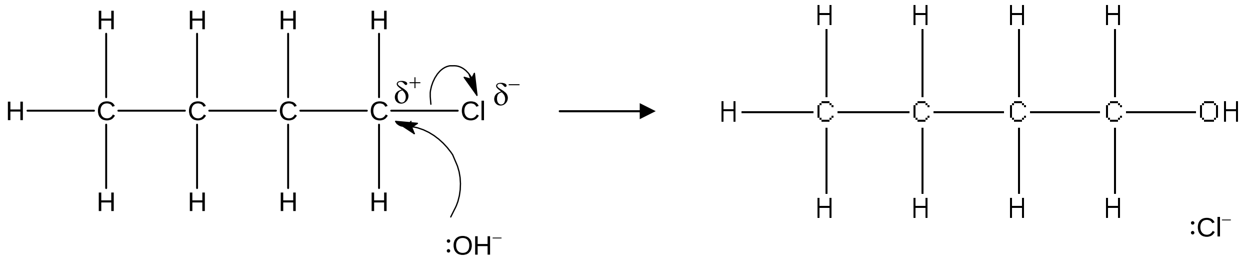
(ii) I (Bromine is added) across the double bond [1]

II Any correct carbocation / H^+ / Cl^+ / NO_2^+ / accept H_2 / accept Cl_2 [1]

III A movement of **two** electrons/an electron pair/a lone pair [1]

Total [14]

11. (a) 1-Chlorobutane is heated / refluxed (1) with aqueous (1) sodium hydroxide.



Correct formulae and charges (1) curly arrows (1) polarisation (1)

The reaction mechanism is nucleophilic substitution (1) [6]

QWC select and use a form and style of writing appropriate to purpose and to complex subject matter [1]
organise information clearly and coherently, using specialist vocabulary when appropriate [1] [2]

(b) (i) (2-)methylpropan-1-ol [1]

(ii) number of moles of compound G $= \frac{0.50 \times 86}{100} = 0.43$ (1)

mass of compound G $= 0.43 \times 74 = 31.8 / 32$ g (1) [2]

(iii) oxidising agent (potassium) dichromate / $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$ (1)

observation orange to green (solution) (1) [2]

accept correct answers based on potassium manganate(VII)

(c) temperature 300°C (1) pressure 60-70 atmospheres (1) [2]

Total [15]

Total Section B [70]

Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1092/01

CHEMISTRY CH2

P.M. FRIDAY, 27 May 2011

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
	11	
TOTAL MARK		

1092
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication used in all written answers.

Page 16 may be used for rough work.

Examiner only

SECTION A

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

1. barium sulfate

calcium carbonate

magnesium hydroxide

sodium carbonate

From the list above, choose the compound that

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

....

(b) is the **most** soluble in water. [1]

....

2. Complete the table below to show the type or types of bonding present in the following solids. [2]

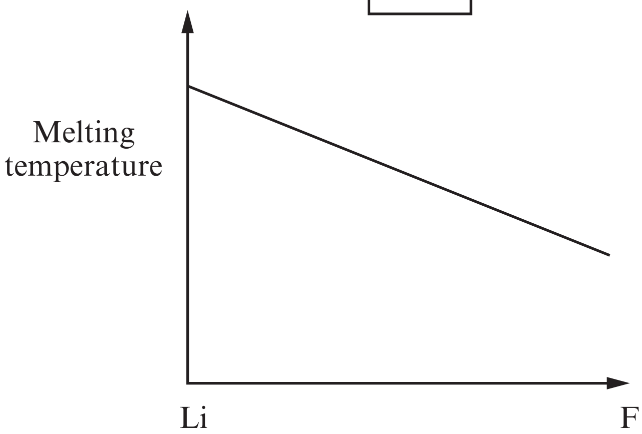
Solid	Type or types of bonding
calcium	
iodine	

3. Calcium phosphate is found widely in nature, e.g. in bones and in the leaves of plants. The formula for the phosphate ion is PO_4^{3-}. Write the formula for calcium phosphate. [1]

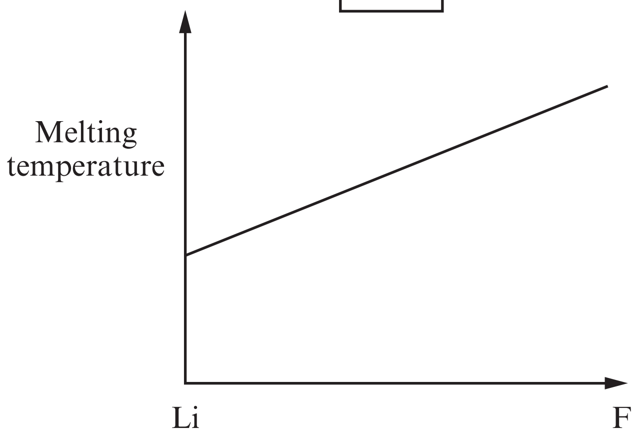
....

4. State which one of the following graphs best shows how melting temperature changes across period 2 in the Periodic Table. [1]

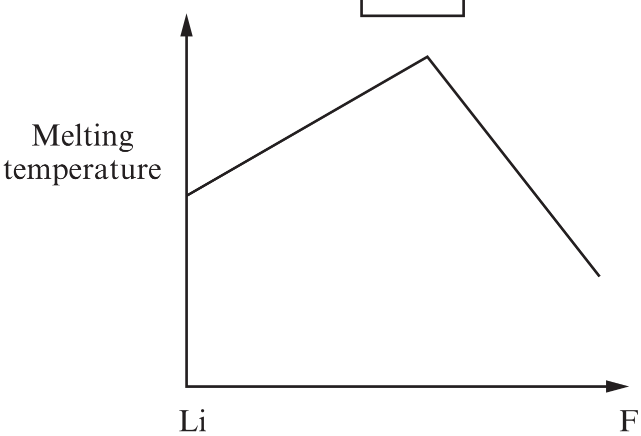
A



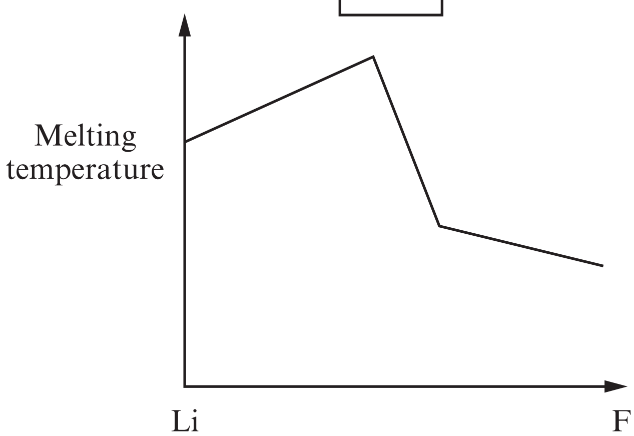
B



C



D



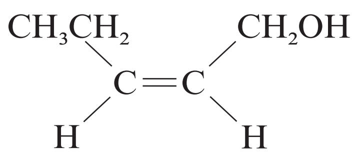
....

5. In recent years scientists have developed a range of materials known as smart materials. State what is meant by a *smart material*. [1]

....

....

6. The compound below has a cherry odour and is used in the manufacture of fragrance agents.



(a) Name the functional groups present in this compound. [2]

....

(b) State the **molecular** formula of the compound. [1]

....

Section A Total [10]

BLANK PAGE

Turn over.

Examiner only

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]

....

....

....

(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]

....

(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]

....

....

....

Examiner only

(d) Describe the structure of and bonding in an ethene molecule. [3]
QWC [1]

You may use a diagram in your answer.

....

....

....

....

....

(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

1092 010007

(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.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

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

....

....

....

....

Total [16]

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]

....

....

....

....

....

....

....

....

(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]

....

....

....

....

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]

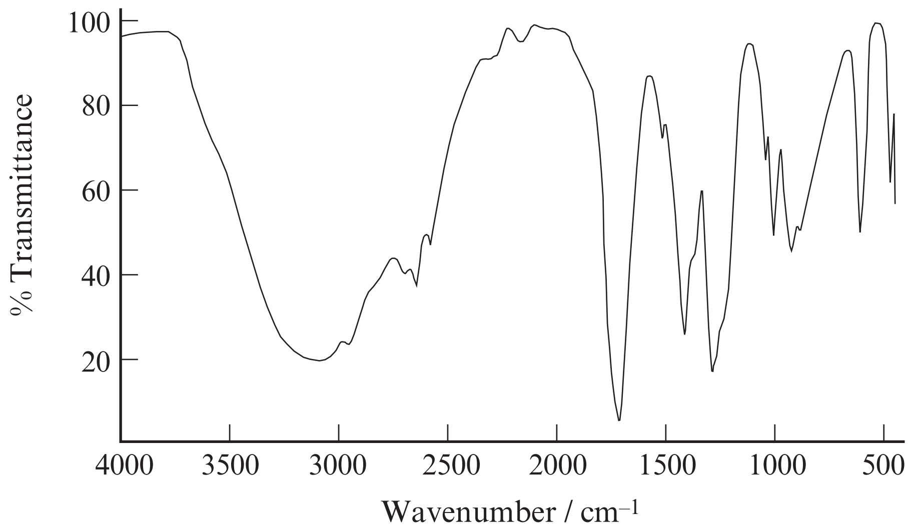
....

Total [13]

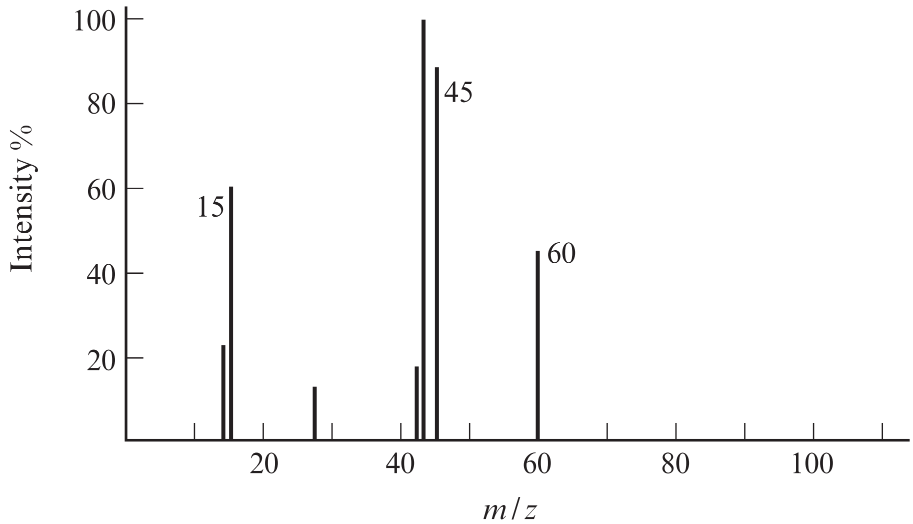
Examiner only

9. Ethanoic acid, CH_3COOH, commonly known as acetic acid, is an organic acid that gives vinegar its sour taste and pungent smell.

(a) Ethanoic acid contains C—O, C=O and O—H bonds and has the infrared spectrum shown below. Using the Data Sheet, label the characteristic absorptions for **each** of these **three** bonds on the spectrum. [2]



(b) The mass spectrum of ethanoic acid is shown below.



Explain how this shows that the formula for ethanoic acid is CH_3COOH. [2]

....

....

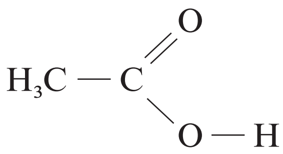
....

....

Examiner only

(c) The crystal structure of ethanoic acid shows that the molecules are found in pairs with hydrogen bonds between each pair.

(i) Complete the diagram to show how **two** molecules of CH_3COOH can join together through hydrogen bonding. [1]



(ii) Describe what is meant by *hydrogen bonding*. [3]
QWC [1]

....

....

....

....

....

....

(d) Ethanoic acid can be formed from the oxidation of ethanol by potassium dichromate(VI).

(i) State the conditions required for this reaction to take place. [1]

....

(ii) State what you would observe during the reaction. [1]

....

(e) The boiling temperature of ethanol is 78 °C. Giving a reason in **both** cases, state how you would expect the boiling temperatures of the following compounds to differ from that of ethanol. [2]

Propane ....

....

....

Butan-1-ol ....

....

....

Total [13]

Turn over.

Examiner only

10. Because of its many uses, over 100 million tonnes of ammonia are manufactured each year.

(a) One of the main uses of ammonia is in the production of nitric acid. In the first part of this process a mixture of ammonia and air is passed over a catalyst at 850 °C.

$$\square\ NH_3(g) + \square\ O_2(g) \longrightarrow \square\ NO(g) + \square\ H_2O(g)$$

(i) Balance the equation above. [1]

(ii) Complete the table below, giving the oxidation states (numbers) of each element present and use these to explain which species has been oxidised in this reaction. [3]

Element	Initial oxidation state	Final oxidation state
nitrogen		
hydrogen		
oxygen		

....

....

(iii) Explain in terms of VSEPR theory why ammonia, NH_3, and boron trifluoride, BF_3, have different shapes. [3]

....

....

....

....

....

....

Examiner only

(b) A significant amount of ammonia is also used as a general purpose cleaner for many household surfaces.

Household ammonia is an alkaline solution formed by mixing ammonia with water.

$$NH_3(g) + H_2O(l) \longrightarrow NH_4^+(aq) + OH^-(aq)$$

(i) The ammonium ion shows *coordinate bonding*. Explain what is meant by this term. [1]

....

....

(ii) Using outer electrons only, draw a dot and cross diagram to show the bonding in an ammonium ion. Include the charge on the ion. [2]

(iii) State the shape of an ammonium ion and the bond angle present. [2]

Shape ....

Bond angle ....

(iv) Another compound that contains ammonium ions is ammonium chloride, NH_4Cl. Like sodium chloride it is an ionic compound.

Explain why it is soluble in water. [2]

You may use a diagram in your answer.

....

....

....

....

Total [14]

Examiner only

11. Dr Ballard carries out a series of experiments in the laboratory using Group 1 metals.

(a) In the first experiment, he ignites potassium and puts it in a gas jar containing oxygen to form potassium oxide.

(i) State what he would **see** as the reaction proceeds. [2]

....

....

....

(ii) Write a balanced equation for the reaction. [1]

....

(iii) He repeats the experiment with rubidium.
State whether you would expect rubidium to be more reactive or less reactive than potassium. Give a reason for your answer. [2]

....

....

....

(b) In the second experiment, Dr Ballard reacts sodium with water at room temperature.

$$2Na(s) \;+\; 2H_2O(l) \longrightarrow 2NaOH(aq) \;+\; H_2(g)$$

(i) If the mass of sodium is 0.098 g, calculate the number of moles of sodium used in the experiment. [1]

....

....

(ii) Calculate the volume of hydrogen produced in this reaction at room temperature. [2]

(1 mole of gas occupies 24.0 dm^3 at room temperature)

....

....

(iii) If the volume of water used was 200 cm^3 calculate the concentration, in $mol\,dm^{-3}$, of the sodium hydroxide solution formed. [2]

....

....

Examiner only

(c) In the final experiment, Dr Ballard heats a piece of sodium and puts it in a gas jar containing chlorine to form sodium chloride.

(i) Apart from wearing safety goggles, give **one** precaution that Dr Ballard should take when using chlorine. [1]

....

(ii) Sodium chloride is a solid with a melting temperature of 801°C.

I State the crystal co-ordination numbers for sodium chloride. [1]

....

II Explain in terms of bonding why its melting temperature is high. [2]

....

....

....

....

Total [14]

Section B Total [70]

Rough Work

WJEC CBAC

GCE AS/A level

1092/01-A

CHEMISTRY CH2
DATA SHEET

P.M. FRIDAY, 27 May 2011

Infrared Spectroscopy characteristic absorption values

Bond	**Wavenumber / cm^{-1}**
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

THE PERIODIC TABLE

Period	1	2											3	4	5	6	7	0
	s Block		d Block										p Block					
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 ▶ La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) ▶▶ Ac Actinium 89															

Key

A_r	relative atomic mass
Symbol	
Name	
Z	atomic number

f Block

▶ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▶▶ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2011

CHEMISTRY - CH2

SECTION A

Q.1	(a)	Calcium carbonate	[1]
	(b)	Sodium carbonate	[1]
Q.2	Metallic (1) Covalent **and** van der Waals (1)		[2]
Q.3	$Ca_3(PO_4)_2$		[1]
Q.4	D		[1]
Q.5	Materials that change their properties in response to a change in conditions / environment / surroundings		[1]
Q.6	(a)	Alkene / double bond (1) Alcohol / hydroxyl / hydroxy (1)	[2]
	(b)	$C_5H_{10}O$	[1]
			Total [10]

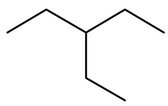
SECTION B

Q.7 (a) Compound that contains no double bonds / single bonds only
(Accept contains maximum number of hydrogens) [1]

(b) (i) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$ [2]

products (1)
balancing (1)

(ii)



[1]

(c) Cracking (1)
Heat fraction strongly / heat over a catalyst (1)
Accept equation or description of cracking [2]

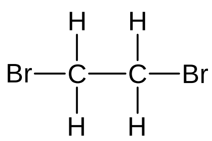
(d) Planar molecule with trigonal arrangement about each atom / bond angles roughly 120° (1)

Four (single) **covalent** C – H bonds and one C = C double bond (1)

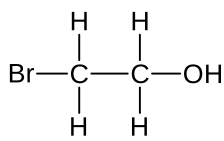
π bond in C = C formed by sideways overlap of p orbital (1) [3]

QWC: Information is organised clearly and coherently, using specialist vocabulary where appropriate. [1]

(e) Electrophilic addition (1)



accept



[2]

(f) Phosphoric acid [1]

(g) Moles ethanol = $\frac{230}{46}$ = 5 (1)

Moles glucose = 2.5 (1)

Mass glucose = 2.5 x 180 = 450 g (1) [3]

Total [16]

Q.8 (a) $C_4H_{10} + Cl_2 \longrightarrow C_4H_9Cl + HCl$ (1)

UV light (1)

any of following for 4 max

$Cl_2 \longrightarrow 2Cl^{\bullet}$ (1)

Free radical substitution / photochlorination (1)

$Cl^{\bullet} + C_4H_{10} \longrightarrow {}^{\bullet}C_4H_9 + HCl$ (1)

${}^{\bullet}C_4H_9 + Cl_2 \longrightarrow C_4H_9Cl + Cl^{\bullet}$ (1)

e.g. $Cl^{\bullet} + Cl^{\bullet} \longrightarrow Cl_2$ (1)

[6]

QWC: Selection of form and style of writing appropriate to purpose and to complexity of subject matter. [1]

(b) $C_4H_9Cl + NaOH \longrightarrow C_4H_9OH + NaCl$ (1)

Nucleophilic substitution / hydrolysis [2]

(c) Heat with NaOH (1)

Add HNO_3 then $AgNO_3$ (1)

White precipitate seen (1) [3]

(d) Ozone layer depleted / (leads to) increased incidence of skin cancer

Contributes to greenhouse effect / increases global warming [1]

Total [13]

Q.9 (a) C=O absorption at 1650–1750 cm^{-1}

C–O absorption at 1000–1300 cm^{-1}

O–H absorption at 2500–3500 cm^{-1}

3 correct peaks labelled

[2]

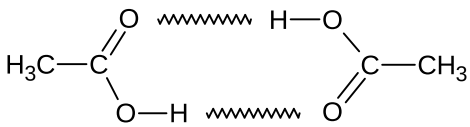
(2 correct peaks labelled 1 mark)

(b) Molecular ion at m/z 60 shows that M_r is 60 (1)

Peak at m/z 15 shows CH_3 group / peak at m/z 45 shows COOH group (1)

[2]

(c) (i)



[1]

(Accept 1 hydrogen bond)

(ii) (Intermolecular bond formed) when hydrogen attached to a highly electronegative atom (oxygen) (1)

is bonded to an electronegative atom in another molecule (1)

forming very strong dipole – dipole attraction (1) [3]

QWC: Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]

(d) (i) Acidified and heat / reflux [1]

(ii) Colour change from orange to green [1]

(e) Propane would be lower as it cannot form hydrogen bonds / only forms van der Waals forces between molecules (1)

Butan-1-ol would be higher as it (also has hydrogen bonds but) has more van der Waals forces between molecules (1) [2]

Total [13]

Q.10 (a) (i) $4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(g)$ [1]

(ii)

Element	*Initial Oxidation State*	*Final Oxidation State*
Nitrogen	–3	2
Hydrogen	1	1
Oxygen	0	–2

All three rows correct (2)
(1 mark if two rows correct)

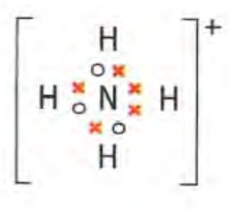
Nitrogen oxidised as its oxidation state has increased (1) [3]

(iii) NH_3 has 3 bonding and 1 non bonding pair of electrons (1)

BF_3 has 3 bonding pairs only (1)

Electron pairs position themselves as far apart as possible
(to minimise repulsion) (1) [3]

(b) (i) A covalent bond where one of the atoms has donated both electrons in the shared pair [1]



charge spread over ion (1)

correct bonding (1)

[2]

(iii) Tetrahedral (1)

109½º (1) (accept 109°) [2]

(iv) Water is polar / a polar solvent (1)
Anion is attracted to $H^{\delta+}$ / cation is attracted to $O^{\delta-}$ (1) [2]

Total [14]

Q.11 (a) (i) Lilac flame (1)

White solid / white fumes / potassium melts (1) [2]

(ii) $4K + O_2 \longrightarrow 2K_2O$ [1]

(iii) More reactive (1)

Electrons in rubidium lost more easily / ionisation energy is less / explanation e.g. increased sheilding (1) [2]

(Need reason to get first mark but accept more reactive as reactivity increases down group for 1 mark)

(b) (i) No. moles = $\frac{0.098}{23}$ = 0.00426 [1]

(ii) Moles H_2 = 0.00213 (1)

Volume H_2 = 0.00213 x 24 = 0.0511 dm^3 (1) [2]

(iii) Moles NaOH = 0.00426 (1)

Concentration NaOH = $\frac{0.00426}{0.200}$ = 0.0213 mol dm^{-3} (1) [2]

(c) (i) Do the experiment in a fume cupboard [1]

(ii) I 6:6 [1]

II Electrostatic forces between the oppositely charged ions (1)

ionic bonds are / ionic lattice is very strong so large amount of energy needed (1) [2]

Total [14]

Section B Total [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

CHEMISTRY CH2

P.M. WEDNESDAY, 23 May 2012

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
	11	
	12	
TOTAL MARK		

1092 010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

MAY121092O101

SECTION A

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

1. The straight-chain alkane containing 19 carbon atoms is called nonadecane.

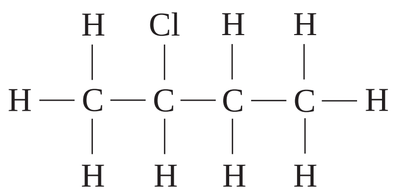
(a) Write the **molecular** formula of nonadecane. [1]

....

(b) When nonadecane is cracked, one of the smaller products formed can be octane.

Write an equation to show the cracking of nonadecane to produce octane. [1]

2. Name the compound whose formula is shown below. [1]



....

3. Draw the displayed formula for (Z)-2-iodobut-2-ene. [1]

4. Chlorine forms a series of oxides that react with water.

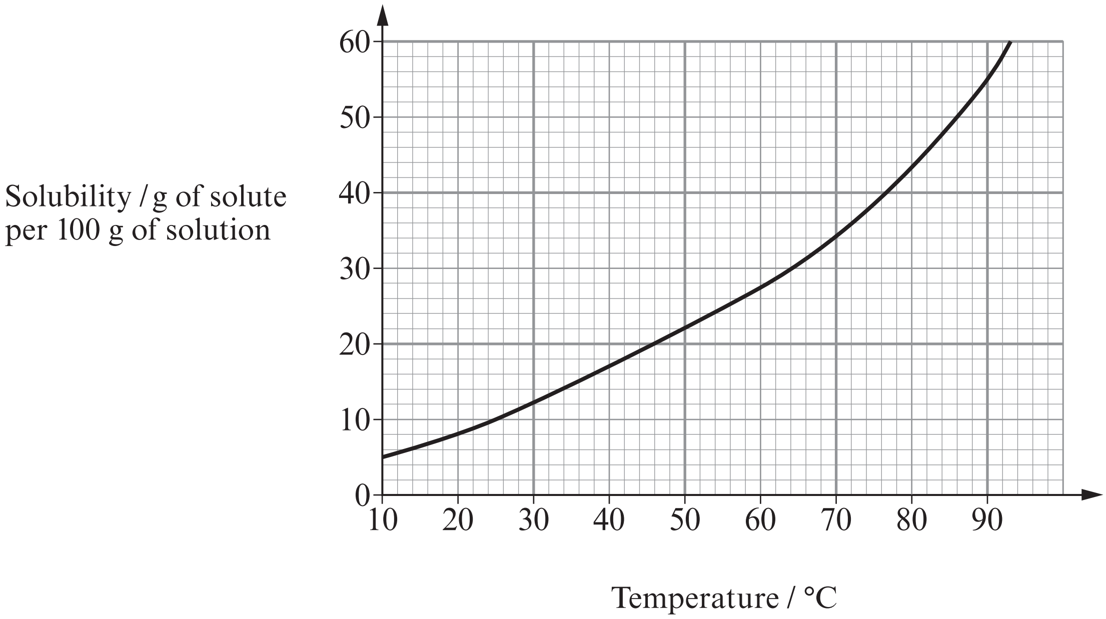
Suggest a pH value for the solution formed when an oxide of chlorine reacts with water. [1]

....

Examiner only

5. A solid was prepared in an impure state and it was then purified by recrystallisation. The solid was dissolved in the minimum amount of water at 90 °C and the solution was cooled to 25 °C.

The solubility curve for the solid in water is shown below.



(a) Use the solubility curve to find the maximum mass of solid that would form from 100 g of solution cooled from 90 °C to 25 °C. [1]

Maximum mass .... g

(b) What effect would it have on your answer to *(a)* if more hot solvent had been used to dissolve the impure solid? Give a reason for your answer. [1]

....

....

1092
010003

Examiner only

6. When the temperature is increased, both solid iodine and diamond change directly into their gaseous state – they sublime.

(a) In each case, name the force or bond that is being overcome when the solid changes into a gas. [2]

Iodine ....

Diamond ....

(b) State, with a reason, which solid would have the higher sublimation temperature. [1]

....

....

Total Section A [10]

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Examiner only

SECTION B

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

7. Boron, B, has the atomic number 5 and it forms a fluoride, BF_3.

(a) BF_3 is used to initiate certain types of addition polymerisation of unsaturated compounds.

(i) Ethene is an example of an unsaturated compound. Describe the bonding between the carbon atoms in ethene. You may wish to draw a labelled diagram. [2]

....

....

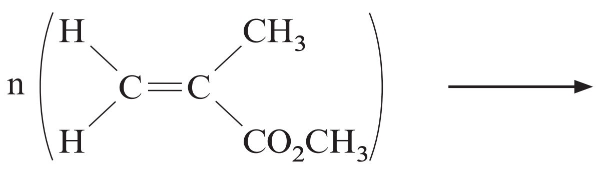
....

(ii) State what is meant by *polymerisation*. [1]

....

....

(iii) A colourless plastic used to cover lights is made from methyl methacrylate by a process similar to the polymerisation of ethene. Complete the equation by giving the formula of the repeating unit. [1]



(iv) Addition polymerisation is used to make synthetic rubber. The molecular formula of the monomer used is C_4H_5Cl. What is the **empirical** formula of the synthetic rubber polymer? [1]

....

Examiner only

(b) (i) Use the VSEPR theory to deduce the shapes of BF_3 and NH_3. [2]

Shape of BF_3 ....

Shape of NH_3 ....

(ii) Explain the difference in the shapes of BF_3 and NH_3. [2]
QWC [1]

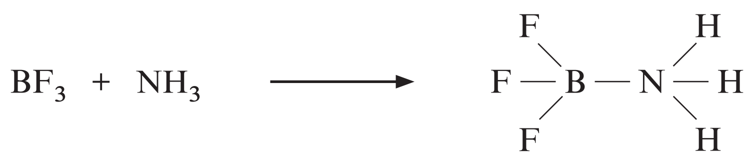
....

....

....

....

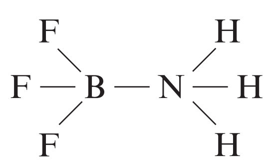
(c) Boron fluoride reacts with ammonia, NH_3, to make the compound shown in the following equation.



(i) Name the type of bond formed between N and B. [1]

....

(ii) Suggest a value for the F–B–F bond angle in this molecule.



Bond angle .... [1]

(iii) Explain your answer to part (ii). [1]

....

....

Total [13]

1092
010007

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]

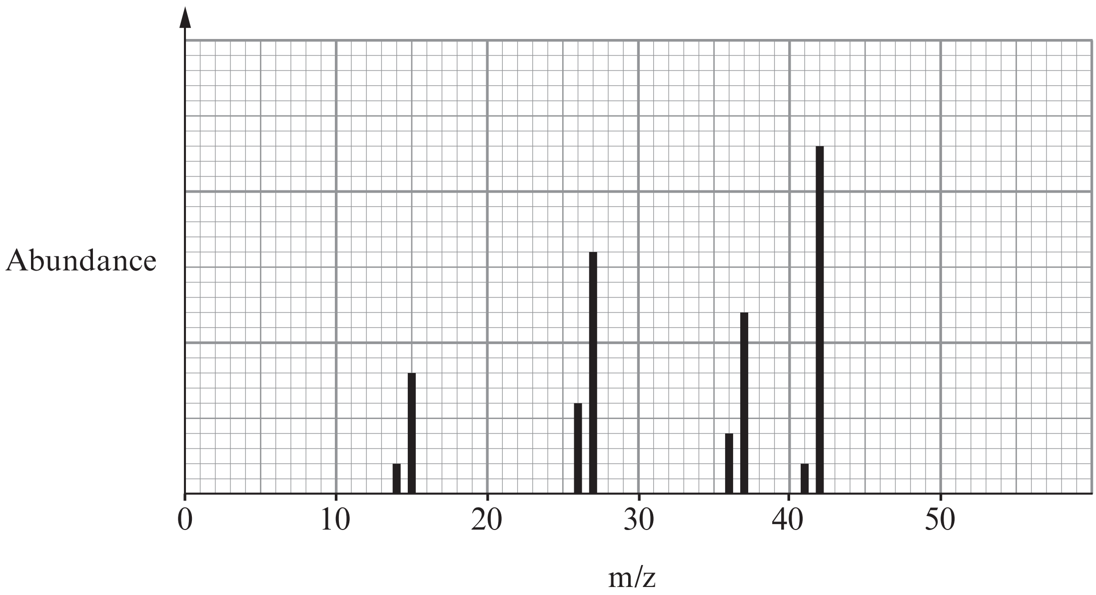
....

....

....

....

(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]

....

....

....

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

....

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

Turn over.

Examiner only

9. Calcium is present in teeth in the form of calcium phosphates. These do not react with water. The element calcium, however, reacts with water to produce calcium hydroxide and hydrogen gas.

$$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$$

(a) A student investigated the reaction between calcium and cold water. He added 2.0 g of calcium to some water and collected the hydrogen gas formed.

Draw a labelled diagram of an apparatus that would be suitable for carrying out this reaction and measuring the volume of hydrogen produced. [2]

(b) The student repeated the reaction using the same mass of barium. He noticed that the volume of gas, still at the same temperature and pressure, was less.

(i) Give the reason why the volume of gas produced was less. [1]

....

....

(ii) Suggest another difference that the student would observe when barium was used in place of calcium. Explain your answer. [2]

....

....

....

(c) The student did not label the flasks containing the solutions after the reactions with calcium and with barium.

Give a test that would distinguish between these solutions. Include the result of your test for both solutions. [2]

....

....

....

Examiner only

(d) Calcium oxide also reacts with water to produce calcium hydroxide. Draw a dot and cross diagram to show the bonding in calcium oxide. Show only the electrons in outer shells. [2]

(e) Barium, as barium sulfate, is used medicinally in barium meals since it is insoluble in water and shows on x-ray images.

(i) Starting from the solution of barium hydroxide the student produced in *(b)*, describe how he could obtain a pure, dry sample of barium sulfate.

You should include an **ionic** equation for the reaction. [3]

....

....

....

....

(ii) Calculate the maximum mass of barium sulfate that the student could make, starting with 2.0 g of barium. [2]

....

....

....

Mass = ... g

Total [14]

Examiner only

10. *(a)* Explain the fact that the melting temperature of sodium is much lower than the melting temperature of magnesium.

You should include reference to the type(s) of bonding involved and how this bonding affects melting temperatures. You may include a diagram if you consider it helpful. [3]

....

....

....

....

....

(b) In an experiment, 1-chlorobutane was heated with aqueous sodium hydroxide and the resulting solution was acidified. Aqueous silver nitrate was then added and a white precipitate was observed.

The experiment was repeated using 1-bromobutane and in this case a cream precipitate was observed.

Explain these observations.

You should include:

- the type of reaction that occurs between the halogenoalkane and sodium hydroxide
- an equation for this reaction
- the identity of the coloured precipitates
- an equation to show the formation of these precipitates. [4]

QWC [1]

....

....

....

....

....

....

Examiner only

(c) Describe how the structures of sodium chloride and caesium chloride are similar and how they are different. Give a reason for any difference.
You may include a diagram if you consider it helpful. [3]

....

....

....

....

....

(d) When hydrogen bromide, HBr, is added to propene, C_3H_6, two different products are possible. In practice, however, more of one of the products is formed.
Explain why more of one product is formed.

You should:

- state the type of reaction involved
- identify the two possible products
- state which of the two products predominates
- give the reason why more of this product is formed. [4]

QWC [1]

....

....

....

....

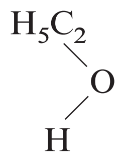
....

....

Total [16]

11. Ethanol, C_2H_5OH, is the alcohol that is present in alcoholic drinks.

(a) Ethanol is soluble in water. Complete the diagram below to show why ethanol is soluble in water. You should include relevant lone pairs and dipoles and label the bond responsible for this solubility. [3]



(b) If it is suspected that a driver has been drinking alcohol they can be tested in several ways.

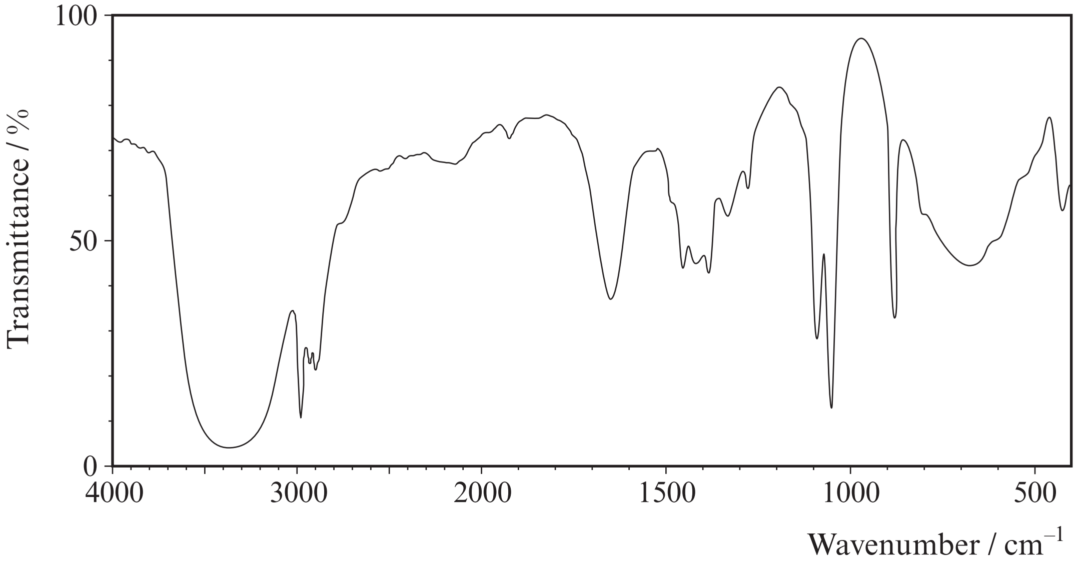
(i) One method previously used to test for ethanol in breath involved blowing through acidified potassium dichromate(VI). A positive test was shown by the colour change from orange to green.

What type of reaction causes this colour change? [1]

....

Examiner only

(ii) Another method uses IR spectroscopy. The IR spectrum for ethanol is shown below.



I State which functional group is shown to be present in ethanol by the absorption at about 3350 cm^{-1}. [1]

....

II A student suggested that this absorption should be used to test for the presence of ethanol in breath. Give a reason why this suggestion is not valid. [1]

....

....

(c) If ethanol, in a drink such as wine, is left in an open bottle and exposed to air it becomes 'sour' and unpleasant to taste. This is because it forms ethanoic acid.

(i) Draw the **displayed** formula of ethanoic acid. [1]

(ii) What significant change would be noticed if the IR spectrum of this product was compared with that of ethanol? Give the reason for this change. [2]

....

....

Total [9]

Examiner only

12. The elements in Group 7 in the Periodic Table can be described as *p*-block elements.

(a) State why these are described as *p*-block elements. [1]

....

....

(b) All halogens are oxidising agents.

(i) Why are the halogens oxidising agents? [1]

....

....

(ii) State, giving a reason, which halogen is the strongest oxidising agent. [1]

....

....

(c) $NaClO_3$ was used as a weedkiller. Give the oxidation state of chlorine in $NaClO_3$.

Oxidation state .... [1]

(d) Methane reacts with chlorine when exposed to sunlight. The first two stages of the mechanism of this reaction are initiation and propagation.

(i) Give the equation for the initiation reaction. [1]

....

(ii) Give equations for **two** propagation steps involved in the formation of chloromethane. [2]

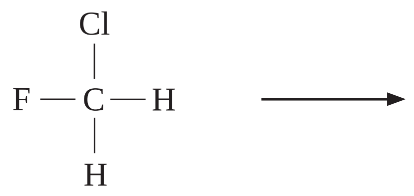
....

....

Examiner only

(e) Chlorofluorocarbons, CFCs, were widely used as refrigerants but they caused serious environmental damage as a result of reactions involving radical mechanisms.

The first stage of a radical mechanism is an initiation process similar to that in *(d)*. Complete the following equation to show the most likely initiation step for chlorofluoromethane, CH_2ClF, and give a reason for your answer. [2]



Reason ....

....

Total [9]

Total Section B [70]

Question number	Write the question numbers in the left-hand margin

Examiner only

Question number	Write the question numbers in the left-hand margin

Examiner only

Question number	Write the question numbers in the left-hand margin

Examiner only

GCE AS/A level

1092/01-A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

P.M. WEDNESDAY, 23 May 2012

Infrared Spectroscopy characteristic absorption values

Bond	**Wavenumber / cm^{-1}**
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

THE PERIODIC TABLE

Group

s Block: Groups 1–2; d Block; p Block: Groups 3–0; f Block

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) ▸▸ Ac Actinium 89															

Key

A_r — relative atomic mass Symbol Name Z — atomic number

f Block

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2012

CH2

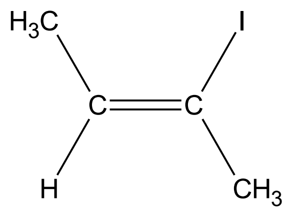
SECTION A

Q.1 (a) $C_{19}H_{40}$ [1]

(b) $C_{19}H_{40} \rightarrow C_8H_{18} + C_{11}H_{22}$ - allow ecf [1]

Q.2 2-chlorobutane [1]

Q.3 [1]



Q.4 any number in range 1 to 6 [1]

Q.5 (a) maximum mass = 44-45 (g) [1]

(b) (less solute would form as a solid) because more will remain in the solution [1]

Q.6 (a) iodine force is Van der Waals/ induced dipole-induced dipole (1)

diamond force is covalent bond/ description of attractive forces in a covalent bond (1) [2]

(b) diamond would have a higher sublimation temperature because it has strong**er** forces/ forces are hard**er** to break [1]

Section A Total [10]

SECTION B

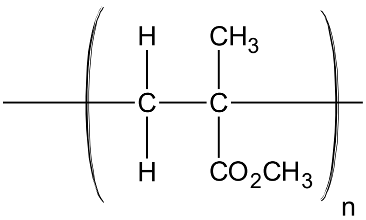
Q.7 (a) (i) one σ bond/ description of σ bond/ diagram to show overlap of s orbitals (1)

one π bond/ description of π bond/ diagram to show sideways overlap of p orbitals (1)

[2]

(ii) joining of **many**/**lots of** (small) units or many alkenes / molecules to make a **large**/**long** unit/ molecule [1]

(iii)



[1]

(iv) C_4H_5Cl [1]

(b) (i) BF_3 is planar triangular/ trigonal planar (1)

NH_3 is pyramidal/ trigonal pyramid (1) [2]

(ii) BF_3 has 3 bond pairs (1)

NH_3 has 3 bond pairs and 1 lone pair (1) [2]

QWC the information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(c) (i) co-ordinate/ dative covalent/ dative
- no credit for 'covalent' [1]

(ii) 109½° (accept any in range 109°-110°) [1]

(iii) 4 bond pairs/ bonds (around B)
- no credit for 'tetrahedral' [1]

Total [13]

Q.8 (a) (i) % H = 14.3 (1)

$$C : H = \frac{85.7}{12.0} : \frac{14.3}{1.01} = 7.14 : 14.16 \text{ (1)}$$

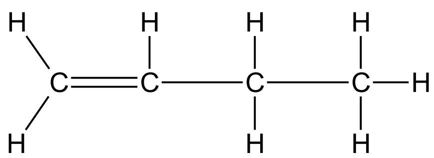
empirical formula = CH_2 (1) [3]

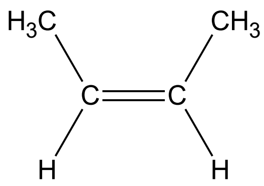
(ii) M_r = 42/ largest fragment has mass 42 (1)

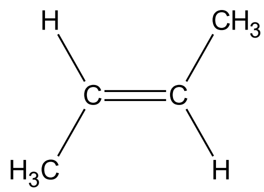
(CH_2 = 14) therefore molecular formula = C_3H_6 (1) [2]

(iii) CH_3 is present [1]

(b) 1 mark for each [3]







Total [9]

Q.9 (a) apparatus in which reaction can occur, e.g. flask/ test tube, and delivery/ rubber tube (1)

apparatus in which to measure volume of gas, e.g. over water with measuring cylinder/ gas syringe (1) [2]

(b) (i) fewer **moles** of barium used / barium has a higher A_r [1]

(ii) reaction faster/ more vigorous/ less cloudy solution formed with barium (1)

because ionisation energy of barium is less/ electrons lost more easily from barium/ barium is lower in the group/
barium hydroxide is more soluble (1) [2]

(c) flame test (1) brick red for calcium **and** (apple) green for barium (1)

OR

add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

white precipitate with Ba^{2+}, less precipitate/ no precipitate with Ca^{2+} (1)
[2]

(d) electrons correct – oxide ion clearly shows that 2 electrons originated from calcium atom (1)
charges correct (1) [2]

(e) (i) add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

filter (1)

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (1)
- state symbols ignored [3]

(ii) moles Ba = 2/137 (1)

mass $BaSO_4 = \frac{2 \times 233.1}{137} = 3.4$ (g) (1) [2]

Total [14]

Q.10 (a) both contain metallic bonds/ positive ions and delocalised electrons labelled on diagram (1)

those in magnesium are stronger/ harder to break/ need more energy to break (1)

because **2** electrons are involved in delocalisation/ attraction to the positive ions (1) [3]

(b) reaction is hydrolysis of halogenoalkane/ nucleophilic substitution of halogenoalkane (1)

$C_4H_9X + OH^- \rightarrow C_4H_9OH + X^-$ X can be Cl or Br (1)

(white precipitate is) silver chloride and (cream precipitate is) silver bromide (1)

$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ or $AgNO_3 + X^- \rightarrow AgX + NO_3^-$ (1)

- state symbols ignored [4]

QWC selection of form and style of writing appropriate to purpose and to complexity of subject matter [1]

(c) caesium ions are bigger than sodium ions – accept 'atoms' (1)

co-ordination number 6 : 6 for sodium and 8 : 8 for caesium (1)

both cubic (1) [3]

(d) reaction is electrophilic addition (1)

two possible products are 1-bromopropane and 2-bromopropane (1)

more 2-bromopropane formed (1)

because of greater stability of intermediate positive ion/ 2° carbocation (1)

[4]

QWC legibility of text; accuracy of spelling, grammar and punctuation, clarity of meaning [1]

Total [16]

Q.11 (a) diagram completed with at least 1 water molecule and indication of interaction between O on one molecule and H on the other (1)

interaction between δ^+ on H and lone pair on O (1)

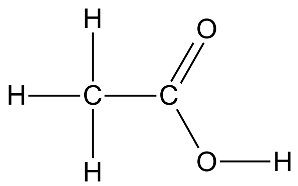
interaction labelled hydrogen bond (1) [3]

(b) (i) reduction/ redox – accept ‘oxidation’ [1]

(ii) I OH [1]

II OH is also present in water [1]

(c) (i) [1]



(ii) peak at 1650-1750 (1)

due to C=O (1) [2]

Total [9]

Q.12 (a) incomplete p sub-shell/ outer electron configuration s^2p^5/ outer electrons in p subshell/ outer electrons in p orbitals/ valence electrons in p subshell/ valence electrons in p orbital [1]

(b) (i) gaining one electron completes shell/ gives p^6/ takes an electron from another species/gains an electron
- do not accept 'attracts an electron' [1]

(ii) **fluorine** because it is the smallest/ has the greatest electron affinity/ has the least shielding/ has the greatest effective nuclear charge/ oxidising power decreases as the group is descended
[1]

(c) oxidation state is (+)5/ V
- do not accept '5+' [1]

(d) (i) $Cl_2 \rightarrow 2Cl^\bullet$ - ignore hf
[1]

(ii) $CH_4 + Cl^\bullet \rightarrow HCl + {}^\bullet CH_3$ (1)

${}^\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl^\bullet$ (1) [2]

(e) products: ${}^\bullet CFH_2$ and $Cl^\bullet$ (1)

C-**Cl** bond is the weak**est**/ **most** easily broken (1) [2]

Total [9]

Section B Total [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

CHEMISTRY – CH2

P.M. TUESDAY, 4 June 2013

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
	11	
TOTAL MARK		

1092
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

J U N 1 3 1 0 9 2 0 1 0 1

Examiner only

SECTION A

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

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

A C_8H_{16}

B C_8H_{17}

C C_8H_{18}

D C_8H_{20}

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]

....

Examiner only

4. Classify the following species as electrophile, nucleophile or radical by completing the table below. [2]

Species	Cl•	NH_3
Classification		

5. Nanoscience involves the study of very small particles. Nano-sized silver particles have antibacterial and antifungal properties. Give **one** use of nano-sized silver particles. [1]

....

....

6. State and explain which two of the following elements combine to form the **most** ionic bond. [2]

chlorine magnesium potassium sulfur

....

....

Total Section A [10]

1092 010003

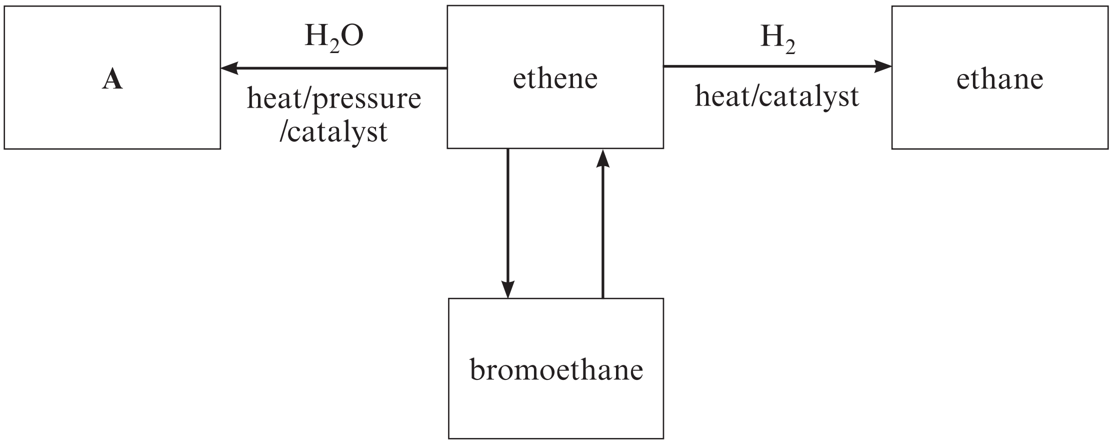
Turn over.

Examiner only

SECTION B

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

7. *(a)* Ethene can be used to make many useful compounds. Study the reaction scheme shown below then answer the following questions.



(i) Draw the **displayed** formula of compound **A**. [1]

(ii) Name the catalyst used in the conversion of ethene to ethane. [1]

....

(iii) Name the reagent(s) and condition(s) necessary to convert bromoethane to ethene. [2]

....

....

(iv) Classify the type of reaction taking place when ethene is formed from bromoethane. [1]

....

Examiner only

(b) In the same way that ethene can be polymerised to give the polymer poly(ethene), propene can form poly(propene).

(i) Draw the repeating unit in poly(propene). [1]

(ii) Calculate how many monomer units are joined together to give poly(propene) if it has a relative molecular mass of 1.05×10^6. [2]

Number of monomer units = ...

(c) (i) A bromoalkane was shown to contain 22.0% carbon and 73.4% bromine by mass. Calculate the **empirical** formula of the compound. [3]

Empirical formula ....

(ii) State what other information would be needed to be able to deduce the **molecular** formula of this compound. [1]

....

Total [12]

1092
010005

Examiner only

8. *(a)* In March 2012 the UK Government proposed a minimum price of 40p per unit of alcohol in an effort to 'turn the tide' against binge drinking.

State **one** effect on the human body and **one** effect on society of the excessive use of alcoholic drinks. [2]

Effect on the human body ....

....

Effect on society ....

....

(b) Butan-1-ol can be prepared by warming 1-chlorobutane with aqueous sodium hydroxide.

(i) Classify the type of reaction occurring and give the mechanism for the reaction. [4]

Reaction type ....

Mechanism

(ii) Use the infrared absorption frequencies given in the Data Sheet to explain how you would know if all the 1-chlorobutane has been converted into butan-1-ol. [2]

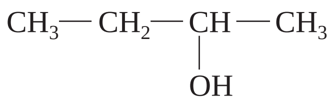
....

....

....

(c) Butan-1-ol has the molecular formula $C_4H_{10}O$.

Two other isomers of $C_4H_{10}O$ are butan-2-ol and methylpropan-1-ol.



butan-2-ol

(i) Draw the **skeletal** formula of methylpropan-1-ol. [1]

(ii) Name the type of isomerism shown by these isomers. [1]

....

(iii) Butan-1-ol can be oxidised by acidified potassium dichromate(VI) to form butanoic acid. State what you would **observe** during this reaction. [1]

....

(iv) Butan-1-ol can also be dehydrated. Name a suitable dehydrating agent and write an equation for this reaction. [2]

Dehydrating agent ....

Equation

....

Examiner only

(d) 1-Chlorobutane is an example of a halogenoalkane. One group of halogenoalkanes (CFCs) has been shown to play a role in ozone depletion. Most of these ozone-depleting substances contain chlorine. Halogenoalkanes containing only fluorine do not harm the ozone layer.

Due to the Montreal Protocol of 1987, CFCs have been largely banned and have been replaced in many applications by HFCs, which contain fluorine as the only halogen.

(i) Explain why CFCs deplete the ozone layer, but HFCs do not. [2]

....

....

....

....

(ii) Suggest a reason why there is still concern about ozone depletion. [1]

....

....

Total [16]

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1092
010009

Examiner only

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 H—$\hat{C}$—H bond angle in a methane molecule. [1]

....

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

QWC [1]

....

....

....

....

....

Examiner only

(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]

Examiner only

10. *(a)* The Group 7 elements chlorine and iodine can both be produced from brine and can be used as disinfectants.

(i) Give the physical states of chlorine and iodine at room temperature. [1]

chlorine ....

iodine ....

(ii) State what is **observed** (if anything) when chlorine and iodine are added separately to potassium bromide solution. Write an equation for any reaction. [3]

Observations ....

....

....

Equation(s) ....

....

(b) Chlorine can react with water to produce oxygen.

$$2Cl_2 \ + \ 2H_2O \longrightarrow 4HCl \ + \ O_2$$

Explain why this reaction is classified as a redox reaction. [2]

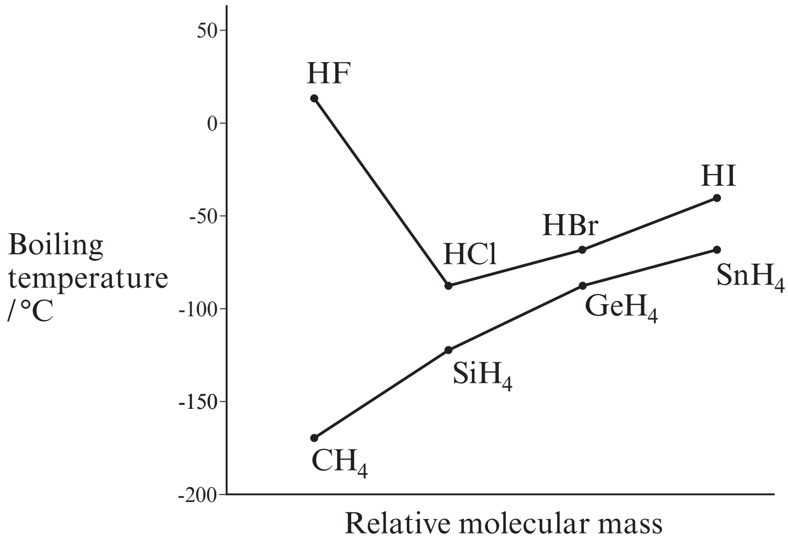
....

....

....

Examiner only

(c) The diagram below shows a plot of boiling temperature against relative molecular mass for the hydrides of Group 7 and Group 4.



(i) Describe the trends in boiling temperatures for the hydrides of Group 7 and Group 4, noting any anomalies. [2]

....

....

....

....

(ii) By reference to the types of intermolecular force present, explain the shape of the plot for the hydrides of Group 7. [3]
QWC [1]

....

....

....

....

....

....

....

QUESTION 10 CONTINUES ON PAGE 14

Turn over.

Examiner only

(iii) Suggest why the boiling temperature of HCl is greater than that of SiH_4. [1]

....

....

....

Total [13]

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Examiner only

11. Jennifer and Marged carry out some experiments with Group 2 metals.

(a) In the first experiment, Jennifer reacts calcium with oxygen to form calcium oxide.

(i) Write an equation for the reaction. [1]

....

(ii) Using outer electrons only, draw a dot and cross diagram to show the transfer of electrons involved in the formation of calcium oxide. Show the charges on the ions formed. [2]

(b) Jennifer then adds water to the calcium oxide. Some of it reacts to form a solution of calcium hydroxide.

(i) Write the formula of calcium hydroxide. [1]

....

(ii) Suggest the pH of this solution. [1]

....

(c) Jennifer reacts the solution of calcium hydroxide with an aqueous solution of sodium carbonate and a white precipitate is seen. Write the **ionic** equation for this reaction. Include the relevant state symbols in the equation. [1]

....

Examiner only

(d) Marged adds a strip of magnesium to dilute hydrochloric acid.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

(i) State what she would **observe** as this reaction proceeds. [2]

....

....

(ii) If the mass of the magnesium strip is 0.503 g and the concentration of the acid is 1.60 mol dm^{-3}, calculate the minimum volume of acid required to react completely with the magnesium, giving your answer to **three** significant figures. [3]

Volume of acid = ... cm^3

(iii) Calculate the volume at room temperature of the hydrogen produced in this reaction. [1]

[1 mol of gas occupies 24.0 dm^3 at room temperature]

Volume of hydrogen = ... dm^3

(iv) Give a test which would confirm the presence of chloride ions in aqueous magnesium chloride, stating the result of the test. [2]

....

....

QUESTION 11 CONTINUES ON PAGE 18

Examiner only

(e) Marged repeats the experiment with beryllium. State whether you would expect beryllium to be more or less reactive than magnesium. Explain your answer clearly. [2]

....

....

....

Total [16]

Total Section B [70]

END OF PAPER

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Examiner only

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Examiner only

GCE AS/A level

1092/01-A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

P.M. TUESDAY, 4 June 2013

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Key

A_r (relative atomic mass) Symbol Name Z (atomic number)

Period	1	2											3	4	5	6	7	0
	s Block		d Block										p Block					
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ▸▸ Actinium 89															

f Block

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2013

GCE CHEMISTRY - CH2

SUMMER 2013 MARK SCHEME

Section A

Q.1 C **[1]**

Q.2 B **[1]**

Q.3 (a) Calcium chloride **[1]**

(b) Magnesium carbonate **[1]**

(c) Sodium sulfate **[1]**

Q.4

Species	Cl●	NH_3
Classification	Radical	Nucleophile

(1 for each box) **[2]**

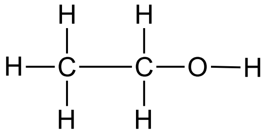
Q.5 e.g. wound dressing/sterilising sprays/deodorant socks/ refrigerator surfaces/anti-perspirants **[1]**

Q.6 Potassium and chlorine (1)

They have the largest electronegativity difference (1) **[2]**

Section B

Q.7 (a) (i) **[1]**

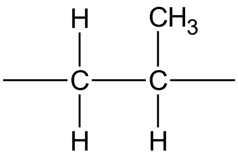


(ii) Nickel / platinum / palladium **[1]**

(iii) Potassium / sodium hydroxide (1)
in ethanol and heat (1) **[2]**

(iv) Elimination **[1]**

(b) (i) **[1]**



(ii) M_r poly(propene) unit = 42 (1)

Number of units = $\dfrac{1.05 \times 10^6}{42}$ = 25000 (1) **[2]**

(c) (i) Percentage hydrogen = 4.6% (1)

C	H	Br	
$\dfrac{22.0}{12}$	$\dfrac{4.6}{1.01}$	$\dfrac{73.4}{79.9}$	(1)
1.83	4.55	0.92	
2	5	1	

Formula = C_2H_5Br (1) **[3]**

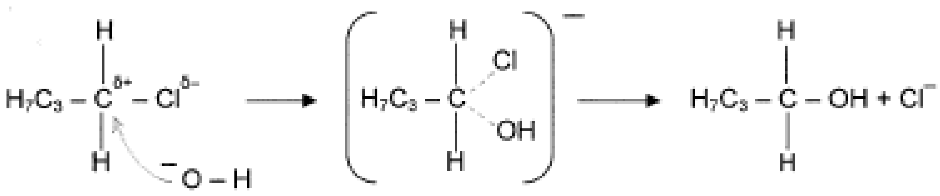
(ii) M_r of compound / number of atoms of any element in compound **[1]**

Total [12]

Q.8 (a) e.g. damages liver/ damages pancreas/causes cancer/causes skin disorders/ short-term effects (1)

e.g. more traffic accidents/violent behaviour/criminal behaviour (1) **[2]**

(b) (i) Nucleophilic substitution / hydrolysis (1)

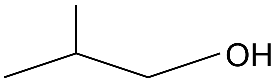


Reactants:	Intermediate (1)
Polarisation (1)	(accept curly arrow to show
curly arrow (1)	C – Cl breaking instead of intermediate) **[4]**

(Incorrect starting material or product maximum 2 marks from 3 for mechanism)

(ii) Peak at 650–800 cm^{-1} due to C – Cl bond will be gone (1)
Peak at 2500–3500 cm^{-1} due to O – H bond /
1000–1300 cm^{-1} due to C – O bond will be present (1) **[2]**

(c) (i)



[1]

(ii) Structural / positional / chain **[1]**

(iii) Colour change from orange to green **[1]**

(iv) Concentrated sulfuric acid / aluminium oxide (1)
$CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CHCH_2 + H_2O$ (1) **[2]**

(d) (i) C – F bond stronger than C – Cl bond (1)
C – Cl bond breaks (in stratosphere) forming Cl● which reacts with ozone (1) **[2]**

(ii) Some CFCs still being used / CFCs take a very long time to reach the ozone layer / other substances deplete the ozone layer **[1]**

Total [16]

Q.9 (a) A mixture of (many) hydrocarbons / alkanes **[1]**

(b) $C_4H_{10} + 6\frac{1}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$ **[1]**

(c) 109½° **[1]**

(d) H_2O has 2 bonding and 2 lone pair of electrons (1)

CH_4 has 4 bonding pairs only (1)

Repulsion between lone pairs and bond pairs is greater than between bond pairs and bond pairs (1) **[3]**

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate *QWC* **[1]**

(e) (i) Butane is higher because it has more van der Waals' forces between molecules **[1]**

(ii) Regular array of metal ions surrounded by a 'sea' of delocalised valence electrons (1)

Strong attraction between the positive ions and the delocalised electrons (1) (Can be obtained from labelled diagrams)

Malleable because when a force is applied the layer of metal ions slide over each other forming a new shape (1)

Conduct electricity since under a potential difference the delocalised electrons flow / the delocalised electrons flow towards the positive potential (1)
[4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning *QWC* **[1]**

Total [13]

Q.10 (a) (i) Chlorine – gas
Iodine – solid **[1]**

(ii) Chlorine – brown/orange solution (1)
Iodine – no change / no reaction (1)
$Cl_2 + 2KBr \longrightarrow Br_2 + 2KCl$ (1) **[3]**
(Accept ionic equation)

(b) Oxygen loses electrons therefore oxidised / oxidation state changes from -2 to 0 therefore is oxidised (1)

Chlorine gains electrons therefore reduced / oxidation state changes from 0 to -1 therefore is reduced (1) **[2]**

(c) (i) Boiling temperatures increase as relative molecular mass increases / number of electrons increases / down group (1)

HF has a higher boiling point than expected (1) **[2]**

(ii) Group 7 hydrides contain more dipole–dipole forces as group descended (1)

but HF contains hydrogen bonding between molecules (1)

Hydrogen bonds are stronger therefore HF's boiling temperature is greater / need more energy to break (1) **[3]**

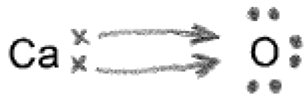
QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter *QWC* **[1]**

(iii) HCl more polar than SiH_4 therefore intermolecular forces are stronger / dipole greater in HCl / Cl more electronegative than Si **[1]**

Total [13]

Q.11 (a) (i) $2Ca + O_2 \longrightarrow 2CaO$ **[1]**

(ii)



(1)

forming Ca^{2+} and O^{2-} ions (1) **[2]**

(b) (i) $Ca(OH)_2$ **[1]**

(ii) 8 – 14 **[1]**

(c) $Ca^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow CaCO_3(s)$ **[1]**

(d) (i) Magnesium disappears / gets smaller (1)
Effervescence / bubbles (of hydrogen) (1)
Heat given off (1) **[2]**
(Accept any 2 points)

(ii) Moles Mg = $\frac{0.503}{24.3}$ = 0.0207 (1)
Moles HCl = 0.0414 (1)
Volume HCl = $\frac{0.0414}{1.6}$ = 0.0259 dm^3 (1) **[3]**

(iii) Volume H_2 = 0.0207 × 24 = 0.497 dm^3 **[1]**

(iv) Add aqueous silver nitrate (1)
White precipitate forms (1) **[2]**

(e) Less reactive (1)

Electrons in beryllium more difficult to lose / ionisation energy is higher (1) **[2]**

(Need reason to get first mark but accept less reactive as reactivity increases down group / outer electron has less shielding etc. for 1 mark)

Total [16]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

CHEMISTRY – CH2

P.M. TUESDAY, 3 June 2014

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 6.**	**10**	
Section B	**7.**	**16**	
	8.	**16**	
	9.	**15**	
	10.	**11**	
	11.	**12**	
	Total	**80**	

1092 010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

J U N 1 4 1 0 9 2 0 1 0 1

Examiner only

SECTION A

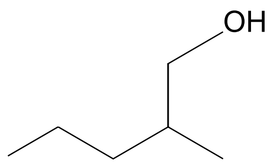
*Answer **all** questions in the spaces provided.*

1. Put the following in order of increasing strength. [1]

covalent bonds *hydrogen bonds* *van der Waals' forces*

weakest .... *strongest*

2. Give the **systematic** name of the compound whose structure is shown below. [1]



....

3. Draw dot-and-cross diagrams to show the formation of calcium chloride from atoms of chlorine and calcium. [2]

Examiner only

4. The table below gives the electronegativity values of some elements.

Atom	H	N	O	Al	Cl
Electronegativity value	2.1	3.0	3.5	1.6	3.0

(a) Use the data in the table to identify any dipoles present in the following bonds. Mark their polarity clearly. [1]

N — H   O — Cl

(b) Use the data to give a reason why aluminium chloride is considered to be a covalent compound, while aluminium oxide is an ionic compound. [1]

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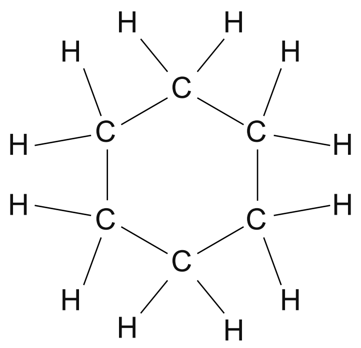
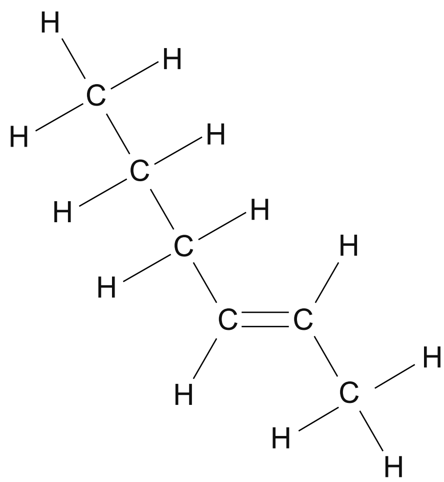
5. Cyclohexane and hex-2-ene are isomers. Give a chemical test to distinguish between these two compounds. [2]



cyclohexane



hex-2-ene

Reagent(s) ....

Observations ....

....

1092 010003

Turn over.

Examiner only

6. Select **all** the molecules from the list below that have bond angles of less than 109°.

A NH_4^+

B BF_3

C NH_3

D CH_4

E SF_6

.... [2]

Section A Total [10]

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1092
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Examiner only

SECTION B

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

7. Ewan and Gwyneth are given four unlabelled bottles. They know that these contain the following four solutions:

potassium carbonate *sodium hydroxide* *barium chloride* *magnesium nitrate*

(a) Ewan predicted what will happen when each of the four solutions is added to the others, and presented this information in the grid below.

	magnesium nitrate	barium chloride	sodium hydroxide
potassium carbonate	white precipitate	white precipitate	no visible change
sodium hydroxide			
barium chloride			

(i) Complete the three empty boxes with the observations expected in each of these cases. [2]

(ii) Name the white precipitate formed when magnesium nitrate is mixed with potassium carbonate, and write an **ionic** equation for its formation. [2]

Name of precipitate ....

Ionic equation ....

Examiner only

(b) Gwyneth uses different tests to identify the four solutions. Each test allows her to distinguish between some of the solutions. For each test state the solution(s) that would give a visible change and the observation(s) that would be made.

(i) Addition of litmus solution [1]

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....

(ii) Flame test [2]

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(iii) Addition of sodium sulfate solution [2]

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Examiner only

(c) Ewan and Gwyneth are provided with a white solid that they believe to be sodium bromide or sodium iodide.

(i) They dissolve the solid in water to make a solution. Explain what occurs when an ionic solid such as sodium bromide dissolves in water. [2]

....

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(ii) Gwyneth uses aqueous silver nitrate to identify the solution. Give the observations expected when silver nitrate is added separately to solutions of sodium bromide and sodium iodide. [2]

Observation with sodium bromide ....

....

Observation with sodium iodide ....

....

(iii) Ewan thinks that a further test is needed after addition of the silver nitrate to distinguish between sodium bromide and sodium iodide. Give the reagent and observations for this further test. [2]

Reagent ....

Observation with sodium bromide ....

....

Observation with sodium iodide ....

....

(iv) When bromine water is added to a solution of sodium iodide, a reaction occurs. Write an equation for this reaction. [1]

....

Total [16]

Examiner only

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]

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(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^3 under these conditions]

Volume = ... dm^3

Examiner only

(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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Examiner only

(c) Naphtha is used as a starting material for the production of alkenes, and these are then used to produce polymers such as poly(ethene). Discuss how poly(ethene) is produced, starting from naphtha. Your answer should include:

- An explanation of which of the two types of crude oil given would be more useful for producing alkenes.
- How the naphtha is converted into alkenes.
- An equation for the production of ethene from decane, an alkane with 10 carbon atoms.
- An explanation of what is meant by polymerisation.
- An equation for the polymerisation of ethene, clearly stating the type of polymerisation that is occurring.
- A different polymer in common use, with the structure of the monomer used in its production. [6]

QWC [1]

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Total [16]

Examiner only

9. Haematite is an ore of iron that contains Fe_2O_3. Iron is extracted from this ore in a blast furnace.

(a) Balance the equation for the extraction of iron from Fe_2O_3. [1]

$$\ldots\ldots\ Fe_2O_3 + \ldots\ldots\ CO \longrightarrow \ldots\ldots\ Fe + \ldots\ldots\ CO_2$$

(b) Use oxidation states to show that the reaction in *(a)* is a redox reaction. [2]

....

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(c) A different oxide of iron is iron(II) oxide, FeO. The ions in this compound adopt an arrangement similar to that of sodium chloride.

(i) Give the crystal co-ordination numbers for the ions in FeO. [1]

....

(ii) Draw the arrangement of oxide ions around each iron ion. [1]

(d) Iron can be extracted from FeO according to the equation below.

$$FeO + CO \longrightarrow Fe + CO_2$$

Calculate the mass of iron that could be extracted from 20.0 kg of iron(II) oxide, FeO. [3]

Mass of iron = ... kg

Examiner only

(e) Carbon monoxide contains two covalent bonds and one co-ordinate bond. Explain what is meant by the terms *covalent bond* and *co-ordinate bond*, indicating the difference between them. [2]

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(f) Iron is a typical metal. Describe the bonding present in iron. Explain how it can conduct electricity and why it has a high melting temperature. [4]
QWC [1]

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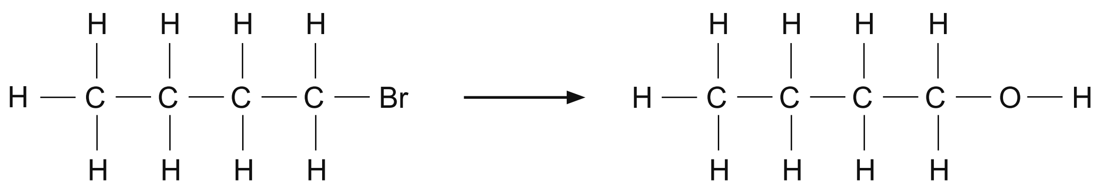
Total [15]

Examiner only

10. *(a)* 1-bromobutane is a liquid that is insoluble in water. It can be converted to butan-1-ol in a one-step reaction.



(i) Give the reagent(s) and condition(s) required for this reaction. [2]

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(ii) Explain why butan-1-ol is soluble in water whilst 1-bromobutane is not. [3]

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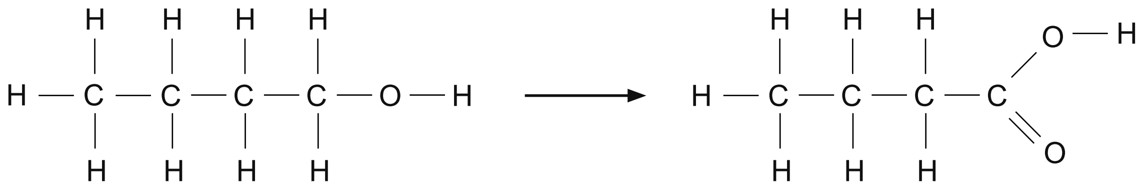
Examiner only

(b) Butan-1-ol can be converted into liquid butanoic acid in a one-step reaction.



(i) Give the reagent(s) and condition(s) required for this reaction. [2]

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(ii) Explain why butanoic acid has a much higher boiling temperature than 1-bromobutane. [3]

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(iii) The reaction above frequently produces a mixture containing unreacted butan-1-ol and butanoic acid. State how these two liquids could be separated. [1]

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Total [11]

Turn over.

Examiner only

11. *(a)* Propene reacts with hydrogen bromide to give 2-bromopropane.

(i) Draw the mechanism for this reaction. [3]

(ii) Explain why the product of this reaction is mainly 2-bromopropane rather than 1-bromopropane. [2]

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Examiner only

(b) Compound **C** is a compound of carbon, hydrogen and bromine only. Bromine has two isotopes, ^{79}Br and ^{81}Br, in equal abundance. Use all the information below to deduce the structure of compound **C**, giving your reasoning. [6]
QWC [1]

- Compound **C** contains 29.8% carbon, 4.2% hydrogen and 66.0% bromine by mass.
- The mass spectrum of compound **C** contains peaks at m/z of 15, 41 and a pair of peaks at 120 and 122.
- The infrared spectrum of compound **C** has absorptions at 550 cm^{-1}, 1630 cm^{-1} and 3030 cm^{-1}.
- Compound **C** is a Z-isomer.

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Total [12]

Section B Total [70]

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

GCE AS/A level

1092/01-A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

P.M. TUESDAY, 3 June 2014

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Key: A_r (relative atomic mass), Symbol, Name, Z (atomic number)

Period	Group 1	Group 2											Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
	s Block		d Block										p Block					
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ▸▸ Actinium 89															

f Block

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2012

CH2

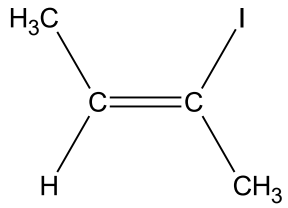
SECTION A

Q.1 (a) $C_{19}H_{40}$ [1]

(b) $C_{19}H_{40} \rightarrow C_8H_{18} + C_{11}H_{22}$ - allow ecf [1]

Q.2 2-chlorobutane [1]

Q.3 [1]



Q.4 any number in range 1 to 6 [1]

Q.5 (a) maximum mass = 44-45 (g) [1]

(b) (less solute would form as a solid) because more will remain in the solution [1]

Q.6 (a) iodine force is Van der Waals/ induced dipole-induced dipole (1)

diamond force is covalent bond/ description of attractive forces in a covalent bond (1) [2]

(b) diamond would have a higher sublimation temperature because it has strong**er** forces/ forces are hard**er** to break [1]

Section A Total [10]

SECTION B

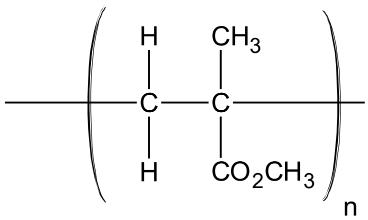
Q.7 (a) (i) one σ bond/ description of σ bond/ diagram to show overlap of s orbitals (1)

one π bond/ description of π bond/ diagram to show sideways overlap of p orbitals (1)

[2]

(ii) joining of **many**/**lots of** (small) units or many alkenes / molecules to make a **large**/**long** unit/ molecule [1]

(iii)



[1]

(iv) C_4H_5Cl [1]

(b) (i) BF_3 is planar triangular/ trigonal planar (1)

NH_3 is pyramidal/ trigonal pyramid (1) [2]

(ii) BF_3 has 3 bond pairs (1)

NH_3 has 3 bond pairs and 1 lone pair (1) [2]

QWC the information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(c) (i) co-ordinate/ dative covalent/ dative
- no credit for 'covalent' [1]

(ii) 109½° (accept any in range 109°-110°) [1]

(iii) 4 bond pairs/ bonds (around B)
- no credit for 'tetrahedral' [1]

Total [13]

Q.8 (a) (i) % H = 14.3 (1)

$$C : H = \frac{85.7}{12.0} : \frac{14.3}{1.01} = 7.14 : 14.16 \ (1)$$

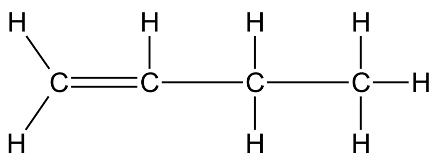
empirical formula = CH_2 (1) [3]

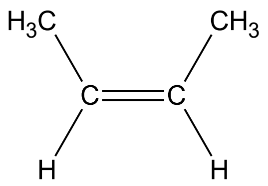
(ii) M_r = 42/ largest fragment has mass 42 (1)

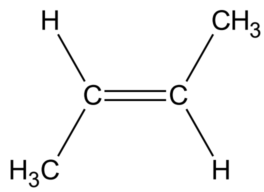
(CH_2 = 14) therefore molecular formula = C_3H_6 (1) [2]

(iii) CH_3 is present [1]

(b) 1 mark for each [3]







Total [9]

Q.9 (a) apparatus in which reaction can occur, e.g. flask/ test tube, and delivery/ rubber tube (1)

apparatus in which to measure volume of gas, e.g. over water with measuring cylinder/ gas syringe (1) [2]

(b) (i) fewer **moles** of barium used / barium has a higher A_r [1]

(ii) reaction faster/ more vigorous/ less cloudy solution formed with barium (1)

because ionisation energy of barium is less/ electrons lost more easily from barium/ barium is lower in the group/
barium hydroxide is more soluble (1) [2]

(c) flame test (1) brick red for calcium **and** (apple) green for barium (1)

OR

add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

white precipitate with Ba^{2+}, less precipitate/ no precipitate with Ca^{2+} (1)
[2]

(d) electrons correct – oxide ion clearly shows that 2 electrons originated from calcium atom (1)
charges correct (1) [2]

(e) (i) add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

filter (1)

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (1)
- state symbols ignored [3]

(ii) moles Ba = 2/137 (1)

mass $BaSO_4 = \frac{2 \times 233.1}{137} = 3.4$ (g) (1) [2]

Total [14]

Q.10 (a) both contain metallic bonds/ positive ions and delocalised electrons labelled on diagram (1)

those in magnesium are stronger/ harder to break/ need more energy to break (1)

because **2** electrons are involved in delocalisation/ attraction to the positive ions (1) [3]

(b) reaction is hydrolysis of halogenoalkane/ nucleophilic substitution of halogenoalkane (1)

$C_4H_9X + OH^- \rightarrow C_4H_9OH + X^-$ X can be Cl or Br (1)

(white precipitate is) silver chloride and (cream precipitate is) silver bromide (1)

$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ or $AgNO_3 + X^- \rightarrow AgX + NO_3^-$ (1)

- state symbols ignored [4]

QWC selection of form and style of writing appropriate to purpose and to complexity of subject matter [1]

(c) caesium ions are bigger than sodium ions – accept 'atoms' (1)

co-ordination number 6 : 6 for sodium and 8 : 8 for caesium (1)

both cubic (1) [3]

(d) reaction is electrophilic addition (1)

two possible products are 1-bromopropane and 2-bromopropane (1)

more 2-bromopropane formed (1)

because of greater stability of intermediate positive ion/ 2° carbocation (1)

[4]

QWC legibility of text; accuracy of spelling, grammar and punctuation, clarity of meaning [1]

Total [16]

Q.11 (a) diagram completed with at least 1 water molecule and indication of interaction between O on one molecule and H on the other (1)

interaction between δ^+ on H and lone pair on O (1)

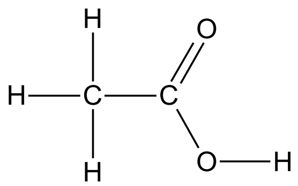
interaction labelled hydrogen bond (1) [3]

(b) (i) reduction/ redox – accept 'oxidation' [1]

(ii) I OH [1]

II OH is also present in water [1]

(c) (i) [1]



(ii) peak at 1650-1750 (1)

due to C=O (1) [2]

Total [9]

Q.12 (a) incomplete p sub-shell/ outer electron configuration s^2p^5/ outer electrons in p subshell/ outer electrons in p orbitals/ valence electrons in p subshell/ valence electrons in p orbital [1]

(b) (i) gaining one electron completes shell/ gives p^6/ takes an electron from another species/gains an electron

- do not accept 'attracts an electron' [1]

(ii) **fluorine** because it is the smallest/ has the greatest electron affinity/ has the least shielding/ has the greatest effective nuclear charge/ oxidising power decreases as the group is descended

[1]

(c) oxidation state is (+)5/ V

- do not accept '5+' [1]

(d) (i) $Cl_2 \rightarrow 2Cl^{\bullet}$ - ignore hf

[1]

(ii) $CH_4 + Cl^{\bullet} \rightarrow HCl + {}^{\bullet}CH_3$ (1)

${}^{\bullet}CH_3 + Cl_2 \rightarrow CH_3Cl + Cl^{\bullet}$ (1) [2]

(e) products: ${}^{\bullet}CFH_2$ and $Cl^{\bullet}$ (1)

C-**Cl** bond is the weak**est**/ **most** easily broken (1) [2]

Total [9]

Section B Total [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1092/01

S15-1092-01

CHEMISTRY – CH2

P.M. TUESDAY, 2 June 2015

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 8.**	**10**	
Section B	**9.**	**13**	
	10.	**12**	
	11.	**16**	
	12.	**15**	
	13.	**14**	
	Total	**80**	

1092 010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

Examiner only

SECTION A

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

1. Complete the electronic structure for the oxide ion present in magnesium oxide. [1]

$1s^2$ ....

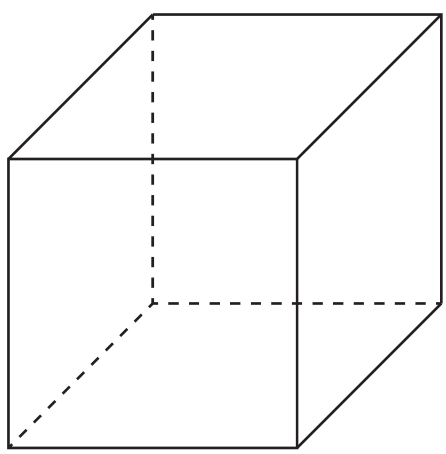
2. Draw a dot and cross diagram to show the bonding in calcium fluoride. You should include outer electrons only and give any charges. [2]

3. Give the meaning of the term *electronegativity*. [1]

....

....

4. Complete and label the diagram to show the positions of the ions present in caesium chloride, CsCl. [1]



Examiner only

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]

$CH_3CH_2CCl{=}CH_2$

....

7. On cracking, one molecule of $C_{20}H_{42}$ can produce one molecule of pentene, one molecule of hexene and one molecule of another product.

Complete the equation for this reaction. [1]

$C_{20}H_{42} \longrightarrow$

1092 010003

8. Draw the repeat unit of the polymer formed from the monomer $CH_3CH_2CH{=}CHCH_3$. [1]

Total Section A [10]

Examiner only

SECTION B

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

9. *(a)* Sodium and potassium both react with cold water but their reactivities are different. The first ionisation energy affects the reactivity of Group 1 elements.

(i) Give an observation that shows the difference in reactivity with cold water between sodium and potassium. [1]

....

....

(ii) Describe the trend in the first ionisation energy of Group 1 elements and explain why this trend occurs. [2]

....

....

....

(iii) Explain how this trend affects the reactivity of Group 1 elements. [1]

....

....

Examiner only

(b) A GCSE student said that, apart from metallic bonding, bonds were either ionic or covalent. An A level student said that this was not really true and that bonds could be intermediate between ionic and covalent.

(i) State **one** factor that governs what type of bond elements form and explain how this leads to different types of bonding. [2]

....

....

....

(ii) Describe the electron density in each type of bond. [3]

Ionic

....

....

Covalent

....

....

Intermediate

....

....

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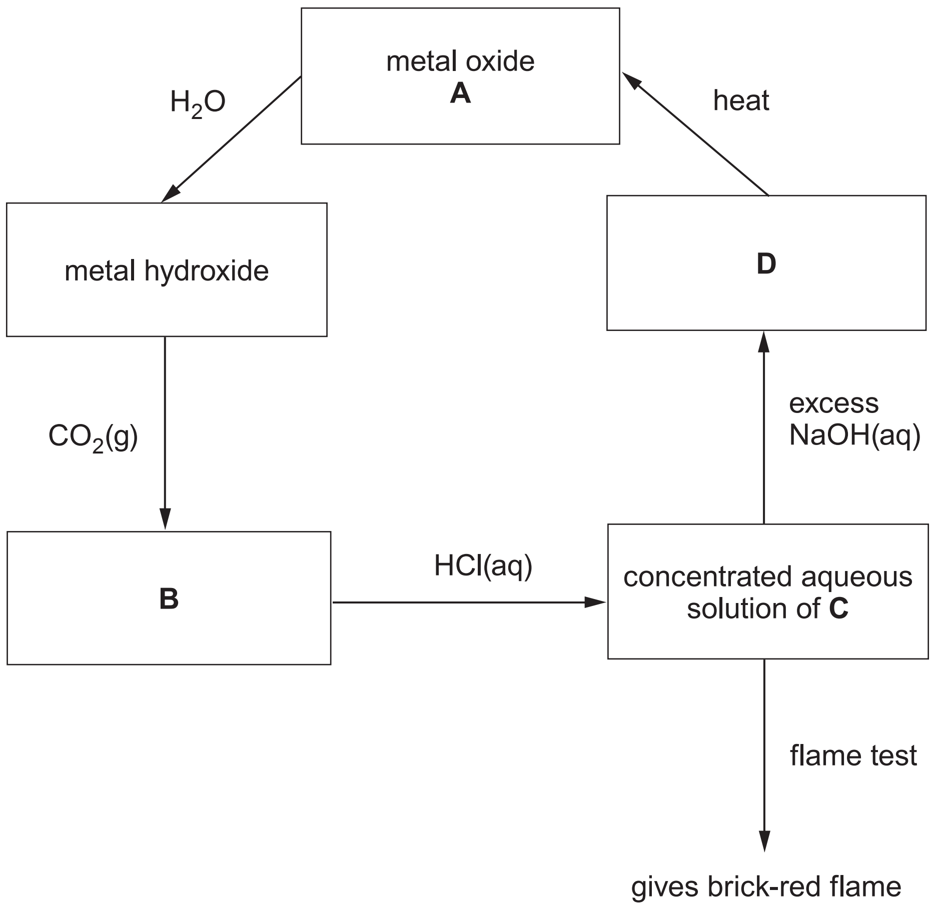
Examiner only

(c) Compound **A** is the oxide of a metal.

The diagram shows some reactions of compound **A**, and associated compounds, that can be carried out in the laboratory.



(i) What metal is present in compound **A**? [1]

....

(ii) What compound containing the metal is present in the aqueous solution **C**? [1]

....

(iii) Describe the appearance of the contents of the test tube with compound **D**. [1]

....

(iv) Write the **ionic** equation for the reaction between solution **C** and aqueous sodium hydroxide. [1]

....

Total [13]

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Examiner only

10. *(a)* State why nitrogen is described as a *p*-block element. [1]

....

....

(b) (i) Draw a dot and cross diagram to show the electrons in the ammonium ion, NH_4^+. You should include outer electrons only. [1]

(ii) State the bond angle in the ammonium ion. Explain why this is the case. [2]

....

....

....

(iii) Ammonia reacts with oxygen to give nitrogen(II) oxide and water. Complete the equation for this reaction. [1]

$$4NH_3 + \ldots\ldots\ O_2 \longrightarrow \ldots\ldots\ NO + \ldots\ldots\ H_2O$$

Examiner only

(c) When sodium nitrate is heated it decomposes.

$$2NaNO_3(s) \longrightarrow 2NaNO_2(s) + O_2(g)$$

(i) Use oxidation numbers to complete the following.

In this reaction .... has been reduced because its oxidation state has

changed from .... to .... [2]

(ii) What volume of oxygen, measured at room temperature and pressure, could be obtained by heating 4.40 g of sodium nitrate? [3]

[The volume of 1 mol of oxygen is 24.0 dm^3 under these conditions]

Volume of oxygen = ... dm^3

(d) A sample of sodium nitrate of mass 65 g was added to 50 g of cold water and the mixture was heated until it all dissolved.

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010009

The table gives information about the solubility of sodium nitrate at various temperatures.

Solubility of $NaNO_3$ / g per 100 g water	Temperature / °C
88	20
96	30
103	40
112	50
122	60
133	70

Use the data in the table to calculate the mass of sodium nitrate that crystallised when the solution was cooled to 30 °C. [2]

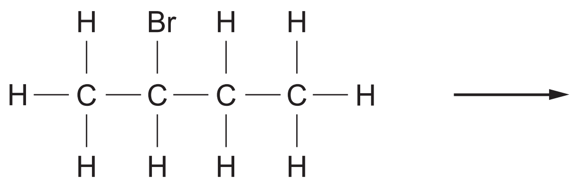
Mass that crystallised = ... g

Total [12]

Examiner only

11. 2-Bromobutane, C_4H_9Br, is a halogenoalkane that behaves in a similar way to 1-chlorobutane.

(a) (i) Complete the diagram below to show the mechanism for the reaction between 2-bromobutane and aqueous sodium hydroxide. You should include relevant charges, dipoles, lone pairs and curly arrows to show the movement of electron pairs. [4]



(ii) What **type** of mechanism is shown in *(a)*(i)? [1]

....

(iii) The reaction involves heterolytic bond fission.

What is meant by *heterolytic bond fission*? [1]

....

....

Examiner only

(b) Bromoethane can be converted into ethene.

(i) Name the reagent and solvent needed to convert bromoethane into ethene. [1]

....

(ii) What **type** of reaction occurs in *(b)*(i)? [1]

....

(iii) 2-Bromobutane behaves in a similar way to bromoethane in this type of reaction. When 2-bromobutane is reacted as described in *(b)*(i) two alkenes that are **structural** isomers are formed.

Draw the displayed formulae of these two alkenes. [2]

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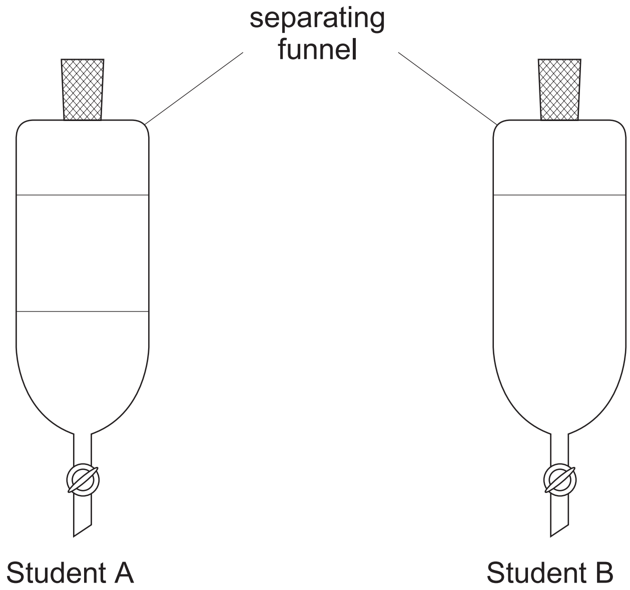
Examiner only

(c) Two students were each given a different alcohol. They each added their alcohol to water in a separating funnel, shook the mixture and then left it to stand.

The diagrams show the results.



What can be deduced about the alcohols given to each student? You should explain why the alcohols behave differently in this experiment. [5]

QWC [1]

....

....

....

....

....

....

....

....

Total [16]

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Examiner only

12. Explain each of the following observations concerning substances that you have met in your study of Chemistry.

(a) Aluminium has a higher melting temperature than sodium.

You should refer to the nature of the bonding. [3]
QWC [1]

....

....

....

....

(b) The colour of an aqueous solution of potassium iodide changes to brown when chlorine is bubbled through.

You should include an equation for the reaction that occurs. [3]

....

....

....

....

(c) Ammonia was used as a refrigerant because it is relatively easy to liquefy. Ethane could not be used for this purpose.

You should refer to intermolecular forces. [4]

....

....

....

....

Examiner only

(d) The reaction between methane and chlorine does not produce a pure sample of chloromethane, CH_3Cl.

You should include the name of the mechanism of the reaction involved and give an equation to show the formation of a product other than chloromethane. [3]
QWC [1]

....

....

....

Total [15]

Examiner only

13. *(a)* An acid **F** was known to be one of the following.

$CH_3CH_2HC{=}CHCO_2H$	Acid 1	M_r = 100
$HO_2CCH_2CH_2CO_2H$	Acid 2	M_r = 118

A sample of 1.20 g of acid **F** was burned in excess oxygen. 1.79 g of carbon dioxide was formed.

(i) Calculate the mass of carbon present in the sample of acid **F**. [1]

Mass of carbon = ... g

(ii) The mass of hydrogen in the sample is 0.061 g. Assuming that the rest of the sample is oxygen, calculate the mass of oxygen in the sample. [1]

Mass of oxygen = ... g

(iii) Use your answers to parts (i) and (ii) to find the empirical formula of acid **F**. [2]

Empirical formula ....

(iv) State the identity of acid **F**. Show clearly how you reached this conclusion. [1]

....

....

Examiner only

(v) Describe a chemical test that would distinguish between Acid 1 and Acid 2. You should include the expected results. [1]

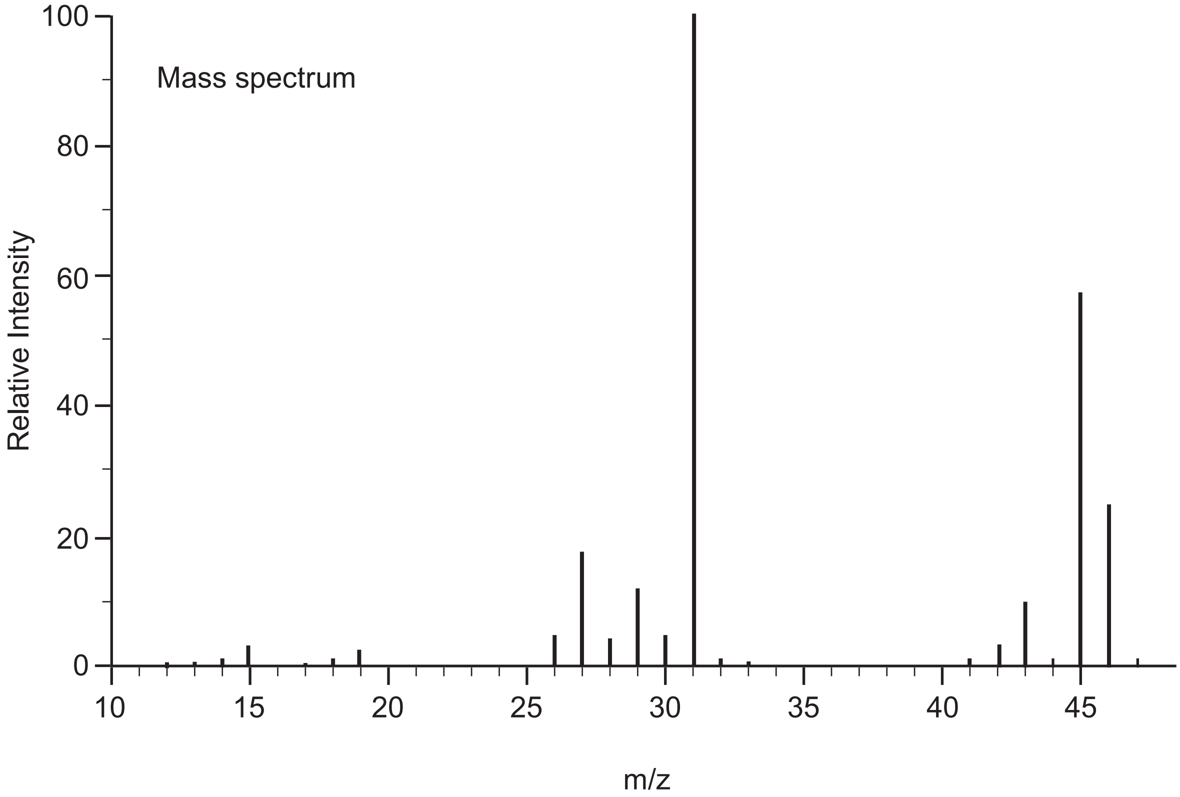
....

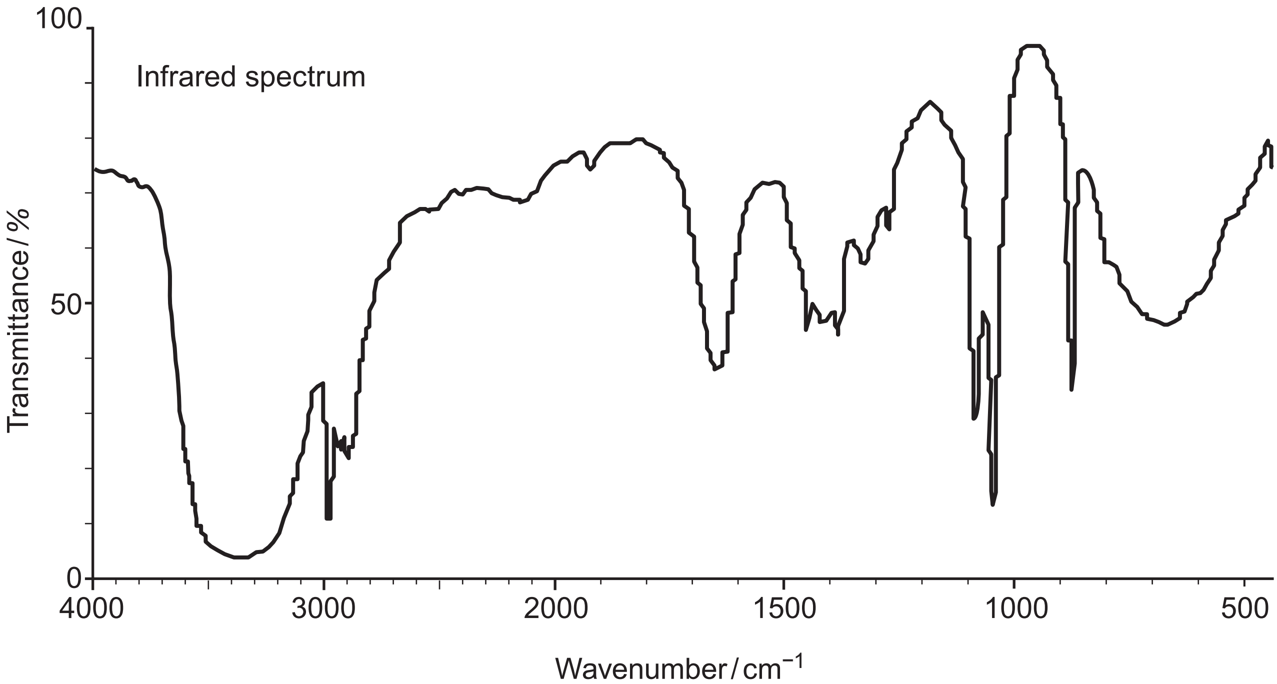
....

(vi) Draw the structural formula of the alcohol that can be oxidised to form Acid 2. [1]

(b) Spectra give much information about the structure of organic compounds.

The mass spectrum and infrared spectrum of ethanol, C_2H_5OH, are shown.





Examiner only

(i) What can be deduced by the presence of the peak at m/z 46 in the mass spectrum? [1]

....

(ii) What can be deduced by the presence of the peak at m/z 15 in the mass spectrum? [1]

....

(iii) What can be deduced by the presence of an absorption peak at 3100 to 3500 cm^{-1} in the infrared spectrum? [1]

....

(c) Ethene can be converted into ethanol and ethanol can be converted into ethene.

For each conversion, state the reagent(s) used and the conditions needed. [4]

ethene to ethanol ....

....

ethanol to ethene ....

....

Total [14]

Total Section B [70]

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

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Examiner only

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Examiner only

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GCE AS/A level

1092/01-A

S15-1092-01A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

P.M. TUESDAY, 2 June 2015

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Group

s Block — d Block — p Block

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ▸▸ Actinium 89															

Key

A_r (relative atomic mass)
Symbol
Name
Z (atomic number)

f Block

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

CH2

SECTION A

1. $(1s^2)2s^22p^6$ [1]

2. 8 electrons in outer shell of all species/ 8 in two F and 0 in Ca (1)

   2+ on calcium ion and 1- on fluoride ions (1) [2]

3. (Electronegativity of an atom is) the tendency of electrons in a covalent bond to be drawn to that atom [1]

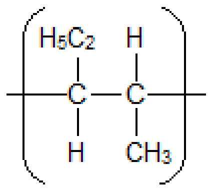
4. Cs^+ and Cl^- (or names caesium and chlor**ide**) with Cl^- at each corner and Cs^+ in centre of cube [1]

5. Reagent: acidified potassium dichromate / $Cr_2O_7^{2-}$ and H^+
   or acidified manganate(VII) / MnO_4^- and H^+ (1)

   Colour change: from orange to green
   or from purple to colourless (1) [2]

6. 2-chlorobut-1-ene [1]

7. $C_{20}H_{42} \rightarrow C_5H_{10} + C_6H_{12} + C_9H_{20}$ [1]

8. 

[1]

Total Section A [10]

SECTION B

9. (a) (i) Potassium bursts into flames sodium does not / potassium darts about surface **more** vigorously than sodium [1]

(ii) 1st ionisation energy decreases as group is descended / as element has higher A_r (1)

(Atom) becomes larger / outer electron further from nucleus / more shielding / less effective nuclear charge (1) [2]

(iii) As group descended outer electron more easily lost [1]

(b) (i) Electronegativity (difference between the atoms) (1)

The bigger the difference the more likely is an ionic bond / ORA for covalent (1) [2]

(ii) Ionic: high electron density centred round ions / shown on diagram (1)

Covalent: high electron density between nuclei/atoms / shown on diagram (1)

Intermediate: high electron density between nuclei/atoms but higher nearer one of them / ions with electron distortion of negative ion (1) [3]

(c) (i) Calcium [1]

(ii) Calcium chloride/ $CaCl_2$ – error carried forward (ecf) from (i) [1]

(iii) White precipitate/ solid – ecf from (i) [1]

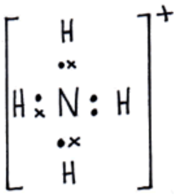
(iv) $Ca^{2+} + 2OH^{-} \rightarrow Ca(OH)_2$ (ignore state symbols) – ecf from (i) [1]

Penalise incorrect metal once only in (c)

Total [13]

10. (a) The last/valence electron entered a p orbital/sub-shell [1]

(b) (i)



do not penalise missing + sign [1]

(ii) 109° – 110° (1)

Pairs of electrons move towards positions of minimum repulsion/ of maximum separation (1) [2]

(iii) $\mathbf{4}NH_3 + \mathbf{5}O_2 \rightarrow \mathbf{4}NO + \mathbf{6}H_2O$ [1]

(c) (i) In this reaction nitrogen (1) has been reduced because its oxidation number has changed from (+) 5 to (+) 3 (1) [2]

(ii) Moles $NaNO_3$ = 4.40/ 85 = 0.0518 (1)

Moles oxygen = 0.0259 (1)

Volume of oxygen = 0.0259 × 24 = 0.62 (dm^3) (1)

Ecf throughout [3]

(d) Mass in solution at 30°C = 96/2 = 48 (g) (1)

Mass that crystallised = 65 – 48 = 17 (g) (1) [2]

Total [12]

11. (a) (i) $\delta-$ on Br and $\delta+$ on C attached (1)

Arrow from lone pair on OH^- to $\delta+$ on C (1)

Arrow from C-Br bond to Br (1)

Correct alcohol + Br^- (1) [4]

(ii) Nucleophilic substitution [1]

(iii) The bond breaks and both the electrons go to one of the bonded atoms/ the bond breaks and ions are formed. [1]

(b) (i) Sodium hydroxide in ethanol/ alcohol [1]

(ii) Elimination/ dehydrohalogenation [1]

(iii) Structural formulae for but-1-ene (1)

and but-2-ene (1) [2]

(c) A is non-miscible with water/ does not mix with water and B is miscible/ mixes with water/ is soluble in water (1)

A has a longer carbon chain/ is bigger (1)

Hydrogen bonding (1)

Between the OH in alcohol and water (1)

In large alcohols non-polar/ hydrophobic part of molecule is large / OH is less significant part of molecule (1) [5]

QWC: organisation of information clearly and coherently; use of specialist vocabulary such as intermolecular force/ hydrogen bond/ hydrophobic/ non-polar/ miscible [1]

Total [16]

12. (a) Any 3 from 4 points:

Bonding is metallic (1)

This is **attraction** between the sea/ delocalised electrons and the positive ions (1)

Al^{3+} has more electrons in the sea than Na^+ / Al^{3+} has a higher charge density than Na^+ (1)

More energy is needed to overcome forces in Al (1) [3]

QWC: legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning [1]

(b) (Brown) iodine is formed (1)

Equation: $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ / $Cl_2 + 2KI \rightarrow 2KCl + I_2$
(ignore state symbols) (1)

Chlorine is a better oxidising agent than iodi**ne**/ has a greater affinity for the electron/ chlorine has oxidised iod**ide** (1) [3]

(c) Ammonia is easily liquefied because it has a high boiling temperature (compared with ethane) (1)

Ammonia contains hydrogen bonds (1)

Ethane has van der Waals forces/ induced dipole-induced dipole forces (1)

Hydrogen bonds are stronger than van der Waals forces (1) [4]

(d) Reaction produces a mixture of halogenocompounds/ more than one halogen can be substituted / ethane (1)

The mechanism is (free) radical (1)

Any equation with product a polychloromethane/ ethane (1) [3]

QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

Total [15]

13. (a) (i) Mass C = 1.79 × 12/44 = 0.488 (g) [1]

(ii) Mass O = 0.65 (g) ecf from part (i) [1]

(iii) C : H : O = 0.488/12 : 0.061/1 : 0.65/ 16 = 0.0407 : 0.061 : 0.0406 (1)

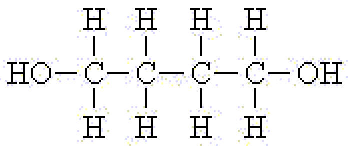
= 2:3:2 empirical formula is $C_2H_3O_2$ (1)

No ecf from incorrect ratios [2]

(iv) *M*r of empirical formula = 59 so molecular formula is $C_4H_6O_4$ so **F** is acid 2/ molecular formula acid 1 is $C_5H_8O_2$ so empirical formula is not $C_2H_3O_2$ molecular formula acid 2 is $C_4H_6O_4$ so empirical formula is $C_2H_3O_2$ [1]

(v) Bromine turns from brown/red-brown to colourless for Acid 1 [1]

(vi)



[1]

(b) (i) *M*r / molecular ion (is 46) [1]

(ii) CH_3 (present) [1]

(iii) OH (present) [1]

(c) Ethene to ethanol: steam (1)

H_3PO_4 (catalyst) (1)

Ethanol to ethene: conc H_2SO_4/ Al_2O_3/ pumice (1)

High temperature > 150°C for H_2SO_4
> 300°C for Al_2O_3/ pumice (1) [4]

Total [14]

Total Section B [70]

Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level

1092/01 – **LEGACY**

S16-1092-01

CHEMISTRY – CH2

P.M. FRIDAY, 10 June 2016

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 7.**	**10**	
Section B	**8.**	**14**	
	9.	**13**	
	10.	**17**	
	11.	**16**	
	12.	**10**	
	Total	**80**	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Sheet** containing a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

1092
010001

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The *QWC* label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

Examiner only

SECTION A

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

1. Barium chloride is used to test for sulfate ions in solution. Give the observation expected for a positive result. [1]

....

2. Draw the **displayed** structure of 2,3-dichloropropene. [1]

3. *(a)* State what is meant by the term *covalent bond*. [1]

....

....

(b) Give a reason why atoms of aluminium and chlorine form covalent bonds in aluminium chloride, whilst aluminium and oxygen form ionic bonds in aluminium oxide. [1]

....

....

Examiner only

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 ($C_{10}H_{22}$) 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]

....

1092 010003

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 $CaSO_4$ / g dm^{-3}
0	2.10
20	2.39

Volume = ... dm^3

Total Section A [10]

SECTION B

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

8. Ethanol can be produced from many different sources.

(a) The original route for producing ethanol was by fermentation of sugars by yeast to produce an aqueous solution of ethanol.

Explain why ethanol is soluble in water. [1]

....

....

(b) In industry, most ethanol is produced from ethene. Give the reagents and conditions for this process. [2]

....

....

(c) Ethanol can be produced from chloroethane in a nucleophilic substitution reaction using aqueous sodium hydroxide.

(i) Use the infrared absorption frequencies given in the data sheet to explain how you could check spectroscopically that this reaction had converted **all** the chloroethane into ethanol. [1]

....

....

....

(ii) Chloroethane can be produced in a similar way to chloromethane.

I. The first stage in the mechanism of this reaction involves homolytic bond fission. Explain what is meant by the term *homolytic bond fission*. [1]

....

....

II. Complete the equation for the propagation stage below. [1]

$$C_2H_6 \ + \ Cl\bullet \ \longrightarrow$$

Examiner only

III. This process often produces mixtures of chloroethane, dichloroethane and trichloroethane. State how pure samples of these substances could be obtained from the mixture. [1]

....

....

(iii) Under different conditions sodium hydroxide can react with chloroethane to produce ethene.

I. Give the conditions needed for this reaction. [2]

....

....

II. Classify the mechanism of this reaction. [1]

....

III. Describe the structure and bonding present in an ethene molecule. [3]
QWC [1]

1092 010005

....

....

....

....

....

....

Total [14]

Examiner only

9. Modern artificial fertilisers contain many ions that are used by plants to help their growth. These include potassium ions, ammonium ions, nitrate ions and phosphate ions.

(a) Ammonium ions are tetrahedral.

(i) Draw a dot-and-cross diagram to show the bonding in an ammonium ion. [1]

(ii) State the bond angle in a tetrahedral ion. [1]

....

(iii) State and explain the shape of a molecule of ammonia. [3]

....

....

....

....

(b) Nitrate ions can be prepared from ammonia. The first step in this process is given below.

$$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$$

Use oxidation states to show that this is a redox reaction. [2]

....

....

....

....

Examiner only

(c) Phosphates form an essential part of fertilisers, and most of the phosphate minerals in the world are found in Morocco. Many of these phosphate minerals are a mixture of calcium phosphate and calcium carbonate.

(i) Calcium and potassium ions may be distinguished using a flame test. State the colours seen for each of these ions. [1]

Potassium ions ....

Calcium ions ....

(ii) One way to convert calcium carbonate to calcium phosphate is to use phosphoric acid. Balance the equation below for this reaction. [1]

.... $CaCO_3$ + ... H_3PO_4 $\longrightarrow$ .... $Ca_3(PO_4)_2$ + ... CO_2 + ... H_2O

(iii) A 1.202 g sample of powdered phosphate mineral was treated with excess acid, and 92.2 cm^3 of carbon dioxide gas were produced. Calculate the percentage of calcium carbonate by mass in the original sample giving your answer to **three** significant figures. [4]

[1 mol of gas occupies 24.0 dm^3 under these conditions]

Percentage = ... %

Total [13]

1092 010007

Examiner only

10. Fatty acids are carboxylic acids that contain a range of saturated or unsaturated hydrocarbon chains attached to a carboxylic acid group, –COOH.

(a) Two fatty acids are propanoic acid and hexanoic acid.

(i) State and explain which of these fatty acids will have the higher boiling temperature. [2]

....

....

....

....

....

(ii) State and explain which of these fatty acids will be more soluble in water. [3]

....

....

....

....

....

....

(b) Pentenoic acid, C_4H_7COOH, has some isomers that can show *E-Z* isomerism and others that cannot.

(i) Pent-2-enoic acid, $CH_3CH_2CHCHCOOH$, can form *E-Z* isomers. Give the **skeletal** formulae for the *E-* and *Z-* isomers of this molecule. [2]

E-isomer *Z*-isomer

Examiner only

(ii) Give the structure of an isomer of pentenoic acid that cannot show *E-Z* isomerism and explain why it cannot. [2]

....

....

....

(c) Arachidonic acid is an unsaturated fatty acid containing more than one double bond.

Bromine water is used to confirm that the fatty acid is unsaturated, with sufficient bromine used to react with **all** the double bonds.

(i) Give the colour change expected in this chemical test. [1]

....

(ii) The product of the reaction of arachidonic acid with excess bromine contains 25.44 % carbon, 3.39 % oxygen and 67.75 % bromine by mass with the remainder being hydrogen.

I. Calculate the empirical formula of this compound. [3]

Empirical formula ....

II. State the number of C═C double bonds present in a molecule of arachidonic acid. Explain how you reached your conclusion. [1]

....

....

....

1092 010009

Examiner only

(iii) HBr reacts with alkenes in a similar way to bromine.
Draw the mechanism for the reaction of HBr with propene to give the major product. [3]

Total [17]

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Examiner only

11. *(a)* (i) Draw the arrangement of ions in solid caesium chloride, labelling the diagram clearly. [2]

(ii) Explain why the coordination numbers of the ions in caesium chloride and sodium chloride are different. [1]

....

....

(b) Explain why the boiling temperature of hydrogen fluoride is much greater than that of hydrogen chloride. [2]

....

....

....

....

....

Examiner only

(c) Sodium chloride and sodium metal can both conduct electricity under different conditions. Give the conditions needed for each to conduct and explain how each conducts electricity. [4]
QWC [1]

....

....

....

....

....

....

....

....

Turn over.

Examiner only

(d) Chlorofluorocarbons (CFCs) are molecules containing only carbon, fluorine and chlorine. They have many uses, although their use has reduced significantly due to the environmental harm they cause.

(i) Give **one** major use of CFCs. [1]

....

(ii) Use the data given in the table to explain why CFCs damage the ozone layer whilst hydrofluorocarbons and chlorobromocarbons are less damaging. [4]
QWC [1]

Bond	Average bond enthalpy / kJ mol^{-1}
C—F	544
C—Cl	338
C—Br	276
C—H	410

....

....

....

....

....

....

Total [16]

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Examiner only

12. Cadwaladerite is a hydrated mineral salt containing three different ions. It is classed as a hydroxyhalide as one ion is hydroxide and a second is a halide ion. The formula is $D_aE_b(OH)_c.xH_2O$ where D is a metal ion and E is the halide ion.

(a) In order to find the value of x in the formula above a sample of cadwaladerite was heated and weighed and the process repeated until the sample reached constant mass.

(i) State why the sample was heated to constant mass. [1]

....

(ii) When 0.023 mol of cadwaladerite was heated to constant mass, the mass lost was 1.658 g. Use this information to calculate the value of x. [2]

x = ...

(b) Another solid sample of 0.0010 mol of cadwaladerite was added to 25.0 cm^3 of hydrochloric acid of concentration 0.104 mol dm^{-3}. The hydroxide ions present neutralised some of the acid leaving 0.0016 mol of acid.

Find the value of *c*, the number of hydroxide ions in each formula unit of cadwaladerite. [2]

c = ...

Examiner only

(c) A sample of cadwaladerite was treated with excess nitric acid until it all dissolved. Excess silver nitrate solution was added and the white precipitate formed was isolated, dried and weighed. 0.0113 mol of cadwaladerite produced 3.243 g of precipitate.

Identify the halide present and the number of halide ions, *b*, present in each formula unit. [3]

Ion E .... *b* = ...

(d) The M_r of cadwaladerite is 187. The remaining ion, D, is formed from a *p*-block metal.

Identify this ion and give the number, *a*, present in each formula unit. [2]

Ion D .... *a* = ...

Total [10]

Total Section B [70]

END OF PAPER

Examiner only

For continuation only.

Examiner only

GCE AS/A level

1092/01-A – **LEGACY**

S16-1092-01A

CHEMISTRY – DATA SHEET
FOR USE WITH CH2

P.M. FRIDAY, 10 June 2016

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
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

THE PERIODIC TABLE

Key

A_r (relative atomic mass)
Symbol
Name
Z (atomic number)

s Block: groups 1–2; d Block; p Block: groups 3–0; f Block

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ▸ Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ▸▸ Actinium 89															

f Block

▸ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
▸▸ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103

GCE MARKING SCHEME

SUMMER 2016

CHEMISTRY - CH2 (LEGACY)
1092-01

INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

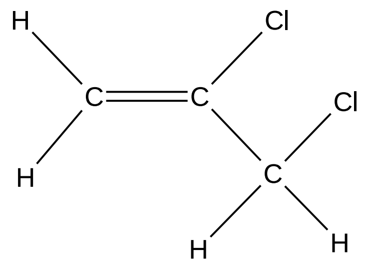
GCE CHEMISTRY - CH2 (LEGACY)

SUMMER 2016 MARK SCHEME

SECTION A

1. White precipitate [1]

2.



[1]

3. (a) Pair of shared electrons, one from each atom [1]

   (b) The difference in electronegativity between aluminium and oxygen is greater than between aluminium and chlorine [1]

4. (a) sodium aluminium magnesium silicon chlorine [1]

   (b) chlorine sodium magnesium aluminium silicon [1]

5. $C_{10}H_{22} \rightarrow C_2H_4 + C_8H_{18}$

   (or alternatives that produce more than one ethene) [1]

6. Acidified (potassium) dichromate(VI) [1]

7. Difference in solubility = 0.29 (1)

   Volume of solution = 0.11 / 0.29 = 0.38 (dm^3) (1) [2]

   Do not accept 0.4 (dm^3)

Total Section A [10]

SECTION B

8. (a) Ethanol can form hydrogen bonds with water molecules [1]

(b) Steam OR water and phosphoric acid (1)

55-80 atm pressure and 200-400°C (1) [2]

(c) (i) Peak at 650-800 cm^{-1} (due to C—Cl bond) in chloroethane will be gone [1]

(ii) I. Breaking of bond with one electron from the bond pair going to each atom/group [1]

II. $C_2H_5\bullet$ + HCl [1]

III. Fractional distillation [1]

(iii) I. Dissolved in ethanol or anhydrous (1)

Heat (1) - accept temperature up to 150°C [2]

II. Elimination [1]

III. Planar / bond angles of 120° (1)

σ bonds between C—H (1)

Sideways overlap of p-orbitals on two carbon atoms (1)

Double bond is π and σ (1)

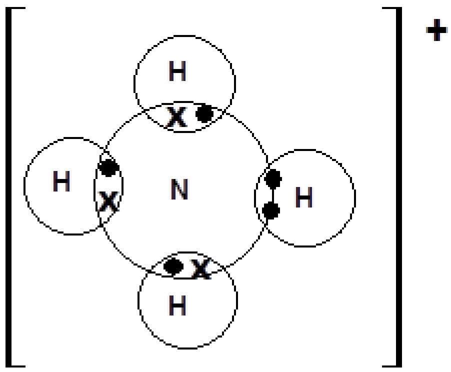
[Single covalent bonds between C—H and double bond between C=C worth 1 mark]

[MAX 3]

QWC *Legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning* [1]

Total [14]

9. (a) (i)



[1]

(ii) 109(.5) ° [1]

(iii) Trigonal pyramidal OR diagram (1)

3 bond pairs and one lone pair (1)

Electron pairs repel each other to be as far apart as possible / lone pair repels more than the bonded pair (1) [3]

(b) Oxidation state of nitrogen goes from -3 to +2 so it is oxidised (1)

Oxidation state of oxygen goes from 0 to -2 so it is reduced (1) [2]

Award (1) if all oxidation states for nitrogen and oxygen given correctly

(c) (i) Potassium ions = lilac

Calcium ions = brick red [1]

(ii) $3CaCO_3 + 2H_3PO_4 \rightarrow (1)Ca_3(PO_4)_2 + 3CO_2 + 3H_2O$ [1]

(iii) Moles of CO_2 = 92.2 /(24 × 1000) = 3.84 × 10^{-3} mol (1)

Mass $CaCO_3$ = 3.84 × 10^{-3} × 100.1 = 0.3846 g (1)

Percentage by mass = 0.3846 / 1.202 × 100 = 32.0 (%) (1)

1 mark for correct answer (or ecf answer) given to three significant figures

If no working shown allow 1 mark for answer given to three significant figures between 31.7% and 32.3%

[4]

Total [13]

10. (a) (i) Hexanoic acid has the higher boiling temperature (reason must be given to award this mark) (1)

(Both molecules have the same amount of hydrogen bonding between molecules) but hexanoic acid has more van der Waals forces between its molecules (1) [2]

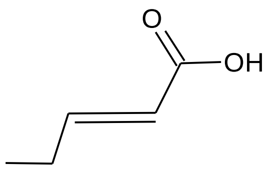
(ii) Propanoic acid has the greater solubility (reason must be given to award this mark) (1)

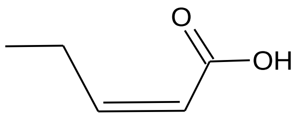
Both can form hydrogen bonds with water molecules (1)

Hexanoic acid has more of the molecule that cannot hydrogen bond (1)

[3]

(b) (i) *E-isomer* *Z-isomer*





1 mark for correct isomers in any representation

Only award marks for skeletal representations of correct isomers

Award (1) for correct representations incorrectly identified

[2]

(ii) Any representation of pent-4-enoic acid

(also accept 3-methylbut-2-enoic acid) (1)

Cannot form *E-Z* isomers as one carbon of the double bond has two of the same group attached OR two hydrogen atoms attached (1) [2]

(c) (i) Orange to colourless [1]

(ii) I. Percentage hydrogen = 3.42% (1)

C: 25.44/12 = 2.12

H: 3.42/1.01 = 3.39

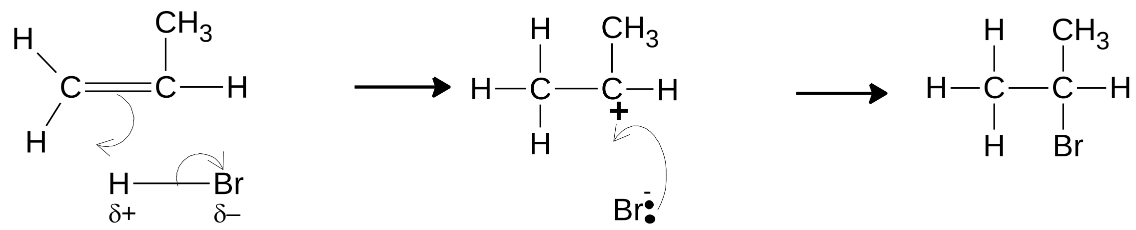
O: 3.39/16 = 0.212

Br: 67.75/79.9 = 0.848 (1)

Empirical formula = $C_{10}H_{16}O_1Br_4$ (1) [3]

II. 4 double bonds – empirical formula has only one oxygen atom but compound has —COOH group [1]

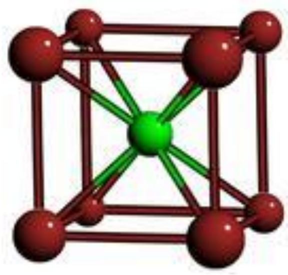
(iii) 1 mark for arrows in first diagram; 1 mark for arrow in second diagram; 1 mark for all charges



[3]

Total [17]

11. (a) (i)



1 mark for showing clear 8 coordination number (1)

Labels for both Cl^- and Cs^+ (either way round) (1) [2]

(ii) Cs^+ ion larger than Na^+ (so can have a larger coordination number) [1]

(b) Hydrogen bonding between molecules in HF but not HCl (1)

Hydrogen bonding stronger than van der Waals/forces in HCl (1) [2]

(c) Sodium metal conducts when solid (or liquid) (1)

Due to a mobile sea of delocalised electrons (1)

Sodium chloride conducts only when liquid/molten OR in solution (1)

As the ions can move (and carry a charge) (1) [4]

QWC *Selection of a form and style of writing appropriate to purpose and to complexity of subject matter* [1]

(d) (i) Refrigerants / aerosols / anaesthetics / fire retardants [1]

(ii) Ozone is broken down by (chlorine) radicals (1)

C—Cl bonds are weak enough to be broken by uv light in the upper atmosphere (1)

C—Br bonds are weaker so the molecule is broken down before reaching the ozone layer / upper atmosphere (1)

C—H or C—F are too strong to break so do not form radicals (1)

[4]

QWC *Organisation of information clearly and coherently; use of specialist vocabulary where appropriate* [1]

Total [16]

12. (a) (i) To ensure **all** water had been removed [1]

(ii) Moles water = 1.658/18.02 = 0.092 (1)

x = 0.092 / 0.023 = 4 (1) [2]

(b) Moles acid at start = 0.104 × 25 /1000 = 0.0026

Therefore acid used = 0.0026 – 0.0016 = 0.0010 (1)

c = 0.0010 / 0.0010 = 1 (1) [2]

(c) Ion E = Cl^- (due to white precipitate) (1) - do not accept 'chlorine'

Moles precipitate = 3.243 / 143.5 = 0.0226 (1)

b = 0.0226 / 0.0113 = 2 (1)

ECF possible [0.0173 with AgBr; 0.0138 with AgI] [3]

(d) M_r due to D = 187 – 72 – 17 – 71 = 27 (1)

[Allow ECF from parts (a), (b) and (c)]

This is equivalent to 1 Al so ion D = Al^{3+} and a = 1 (1) [2]

Total [10]

Total Section B [70]