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		
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.

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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]

.....

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.

O—H C—H B—Cl 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]

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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]

.....

.....

.....

.....

(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]

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(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.

$$KMgCl_3 \longrightarrow KCl + MgCl_2$$

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]

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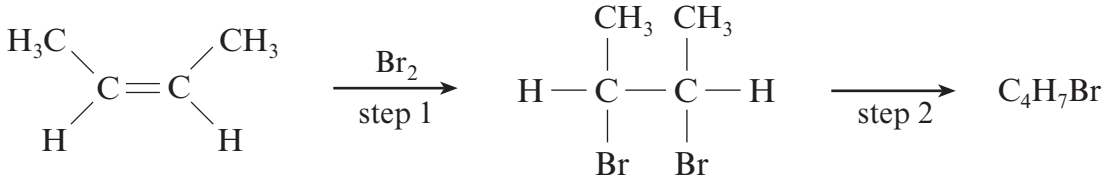
Total [13]

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]

.....

.....

.....

(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]

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

.....

Total [14]

Examiner only

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]

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(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]

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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]

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(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]

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.....

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]

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.....

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

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

.....

.....

(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]

.....

.....

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.....

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

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

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

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

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

Bond	Average bond enthalpy / kJ mol^{-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 δ+ 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]

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]

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(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]

(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]

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Rough Work

WJEC
CBAC

GCE AS/A level

1092/01-A

CHEMISTRY CH2
DATA SHEET

P.M. THURSDAY, 20 January 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