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.

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.

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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]

.....

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

sodium magnesium aluminium silicon chlorine

Lowest ..... *Highest*

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

sodium magnesium aluminium silicon chlorine

Lowest ..... *Highest*

5. Decane ($C_{10}H_{22}$) 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]

.....

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]

Turn over.

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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]

$C_2H_6 + Cl\bullet \longrightarrow$

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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]

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II. Classify the mechanism of this reaction. [1]

.....

III. Describe the structure and bonding present in an ethene molecule. [3]
QWC [1]

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Total [14]

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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]

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.....

(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]

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(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 ⟶ ..... $Ca_3(PO_4)_2$ + ... 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]

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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]

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(ii) State and explain which of these fatty acids will be more soluble in water. [3]

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(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

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(ii) Give the structure of an isomer of pentenoic acid that cannot show *E-Z* isomerism and explain why it cannot. [2]

.....

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.....

(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]

.....

.....

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(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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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]

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.....

(b) Explain why the boiling temperature of hydrogen fluoride is much greater than that of hydrogen chloride. [2]

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(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]

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(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

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Total [16]

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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 = ...

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(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

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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