

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

### 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.

### Section A

### Section B

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.7.	10	
8.	12	
9.	16	
10.	16	
11.	12	
12.	14	
<b>Total</b>	<b>80</b>	

## SECTION A

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

Examiner  
only

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.



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

.....

.....

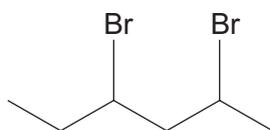
- (b) Draw a dot and cross diagram to illustrate the bonding between the two atoms in chlorine monofluoride. Include **all** *outer* shell electrons. [1]

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

.....

.....

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]

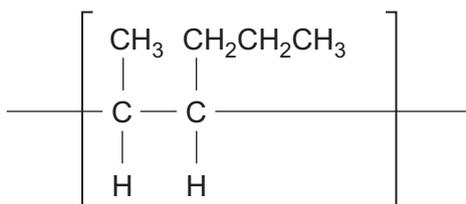
.....

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.

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



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

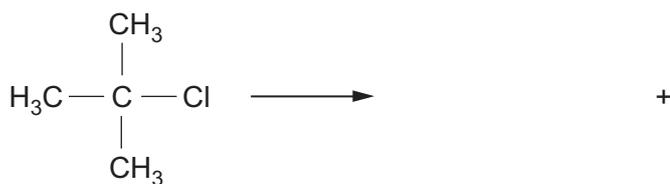
.....

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

[1]

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only

- (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

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only

Answer all questions in the spaces provided.

8. Sulfur difluoride dioxide (sulfuryl fluoride),  $\text{SO}_2\text{F}_2$ , is used as a gaseous insecticide to control termite infestations in wooden houses.

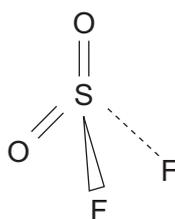
- (a) It can be produced by reacting together sulfur dioxide and fluorine.



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]

- (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,  $\text{SO}_2(\text{NH}_2)_2$ . 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]

- (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,  $\text{CH}_3\text{Br}$ , was formerly used as a fumigant gas to remove insect infestation but has now been largely replaced by sulfur dioxide. 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/ $\text{kJ mol}^{-1}$
C—H	412
C—F	484
C—Cl	338
C—Br	276
S—F	410

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

Total [12]

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

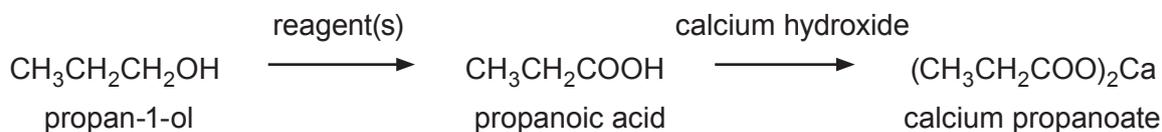
Acid	Formula	Boiling temperature / °C	Solubility in water
ethanoic	CH <sub>3</sub> COOH	118	solubility decreasing ↓
propanoic	CH <sub>3</sub> CH <sub>2</sub> COOH	141	
butanoic	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> COOH		
pentanoic	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> COOH		
hexanoic	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>4</sub> COOH	205	
heptanoic	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>5</sub> COOH	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]
- .....
- .....
- .....
- .....
- .....
- .....
- .....

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

- (b) Calcium propanoate,  $(\text{CH}_3\text{CH}_2\text{COO})_2\text{Ca}$ , is added to bread to prevent mould formation. It can be made from propan-1-ol by the following reactions.



- (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]

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

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

..... mol

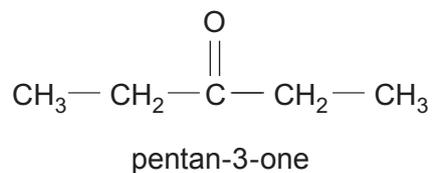
- II State the number of moles of calcium hydroxide needed to just react with all the propanoic acid. [1]

..... mol

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

..... g

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



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

[2]

- (c) A dicarboxylic acid,  $\text{HOOC}-(\text{CH}_2)_n-\text{COOH}$ , 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.

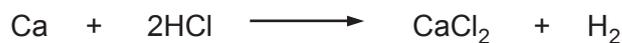
[1]

$n =$  .....

Total [16]

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



- (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<sup>3</sup> 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]

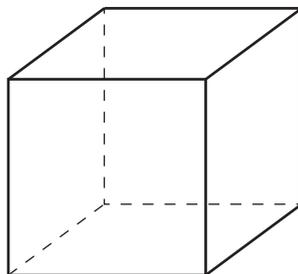
Solubility of compound <b>E</b> /g per 100 g of water	Temperature / °C
0.13	0
0.75	50
1.22	100

Mass that crystallised = ..... g





- (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]

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.....

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.....

.....

Total [12]

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]

.....

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

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



State an essential condition for this stage.

[1]

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

[1]

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

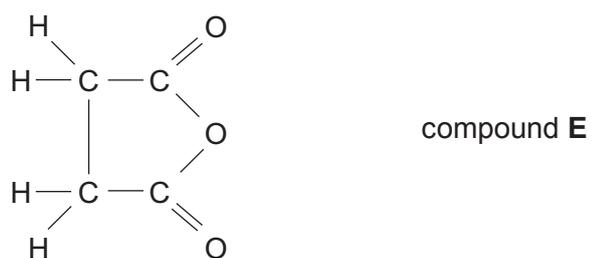
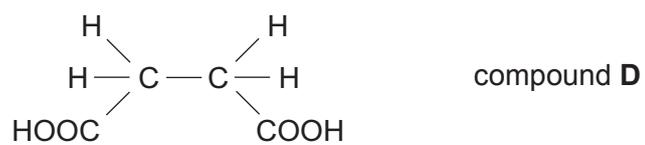
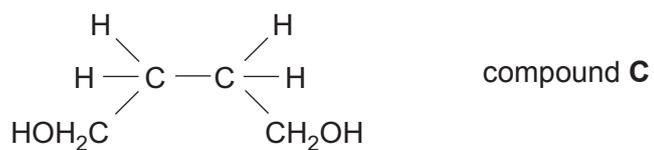
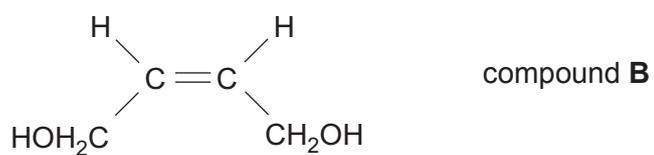
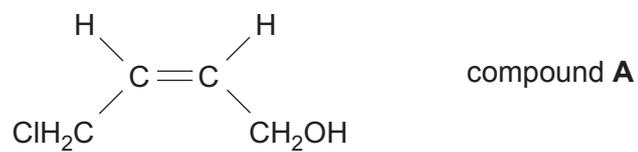
[1]

**QUESTION CONTINUES ON PAGE 18**

Examiner  
only

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

Examiner  
only



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

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

[1]

Examiner  
only

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

[1]

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

[1]

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

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

[2]

Total [14]

**Total Section B [70]**

**END OF PAPER**





**GCE AS/A level**

1092/01-A

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

A.M. THURSDAY, 16 January 2014

**Infrared Spectroscopy characteristic absorption values**

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

# THE PERIODIC TABLE

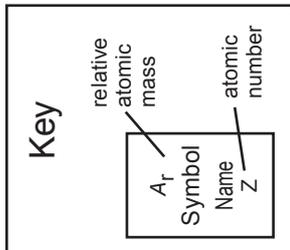
Group

1 2 3 4 5 6 7 0

Period

1 2

	s Block		p Block															
1	1.01 H Hydrogen 1		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	4.00 He Helium 2									
2	6.94 Li Lithium 3	9.01 Be Beryllium 4																
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12																
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

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
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

▶ Lanthanoid elements

▶▶ Actinoid elements