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		

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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SECTION A

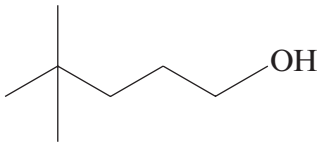
Answer **all** *questions in the spaces provided.*

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

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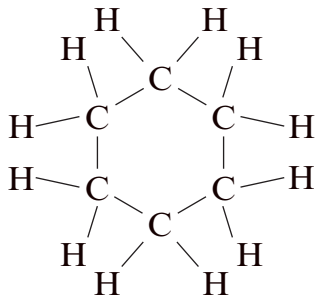
4. Cyclohexane is an example of a hydrocarbon containing a ring of carbon atoms. Its structure is shown below.



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

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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]

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

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

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Total Section A [10]

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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

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(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]

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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]

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.....

(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 .....

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(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) .....

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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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]

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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

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1092/01-A

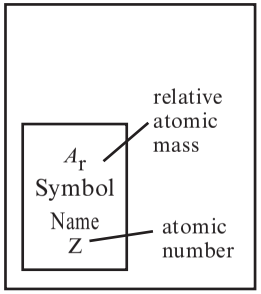
CHEMISTRY – DATA SHEET
FOR USE WITH CH2

A.M. WEDNESDAY, 16 January 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



Period	Group 1	2										3	4	5	6	7	0
	s 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	d Block									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

(1092-01A)