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**
1.7.	**10**	
8.	**12**	
9.	**16**	
10.	**16**	
11.	**12**	
12.	**14**	
Total	**80**	

Section A
Section B

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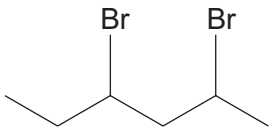
4. *(a)* State the **molecular** formula of compound **L** that has the skeletal formula shown.



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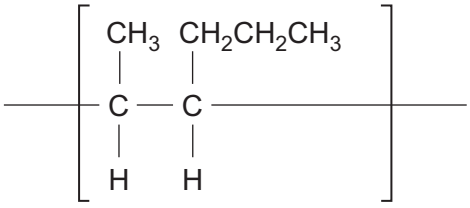
6. A section of an addition polymer is shown below.



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

.....

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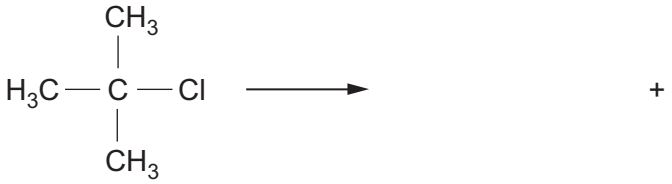
7. *(a)* State the meaning of the term *heterolytic fission*. [1]

.....

.....

(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.

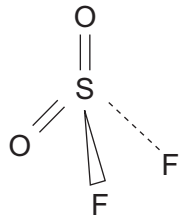
$$SO_2 + F_2 \longrightarrow SO_2F_2$$

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]

.....

.....

(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]

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(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]

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(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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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]

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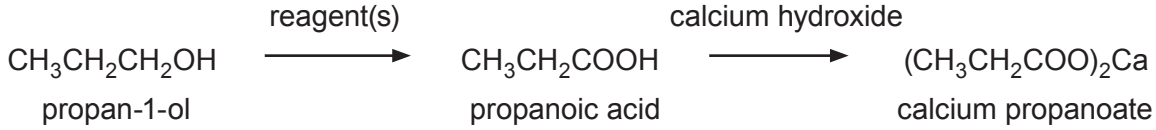
(b) Calcium propanoate, $(CH_3CH_2COO)_2Ca$, is added to bread to prevent mould formation. It can be made from propan-1-ol by the following reactions.



(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 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

Turn over.

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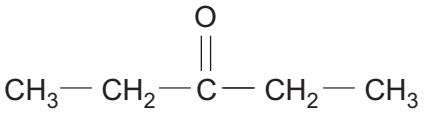
(iv) Calcium propanoate produces pentan-3-one when it is strongly heated.



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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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

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

(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

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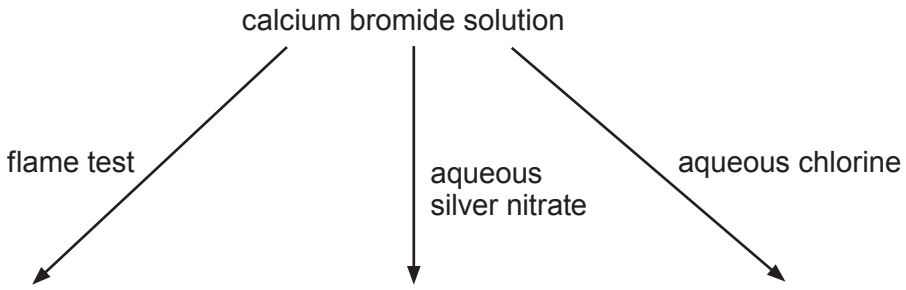
(c) A student was given a solution of calcium bromide and asked to carry out the reactions shown in the diagram below.



(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]

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Total [16]

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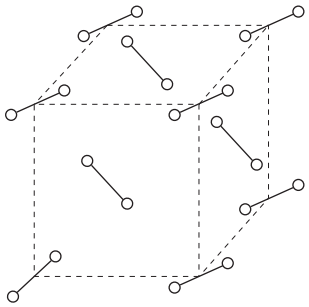
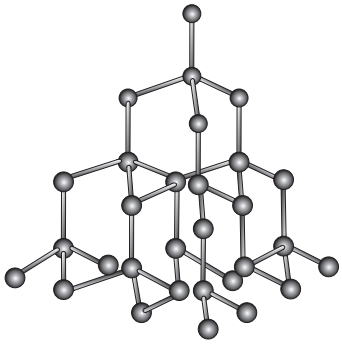
11. *(a)* The structures of solid iodine and diamond are shown below.



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]

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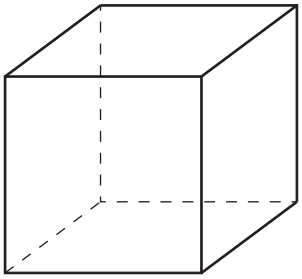
(b) Potassium iodide has the same cubic structure as sodium chloride. Use the diagram below to identify and show the positions of the species involved. [2]



(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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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

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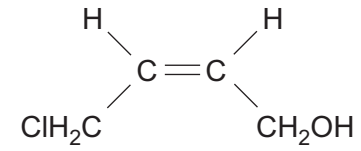
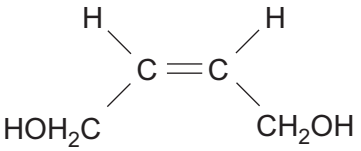
(d) Study the reaction sequence below and then answer the questions that follow.

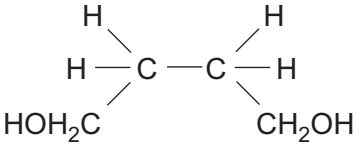


compound **A**

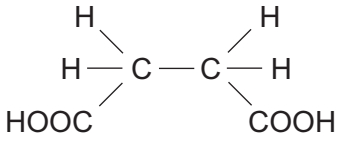
reagent **W**



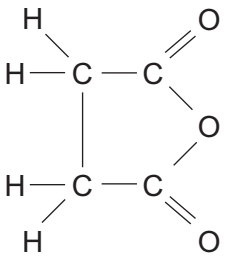
compound **B**



compound **C**



compound **D**



compound **E**

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(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

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GCE AS/A level

1092/01-A

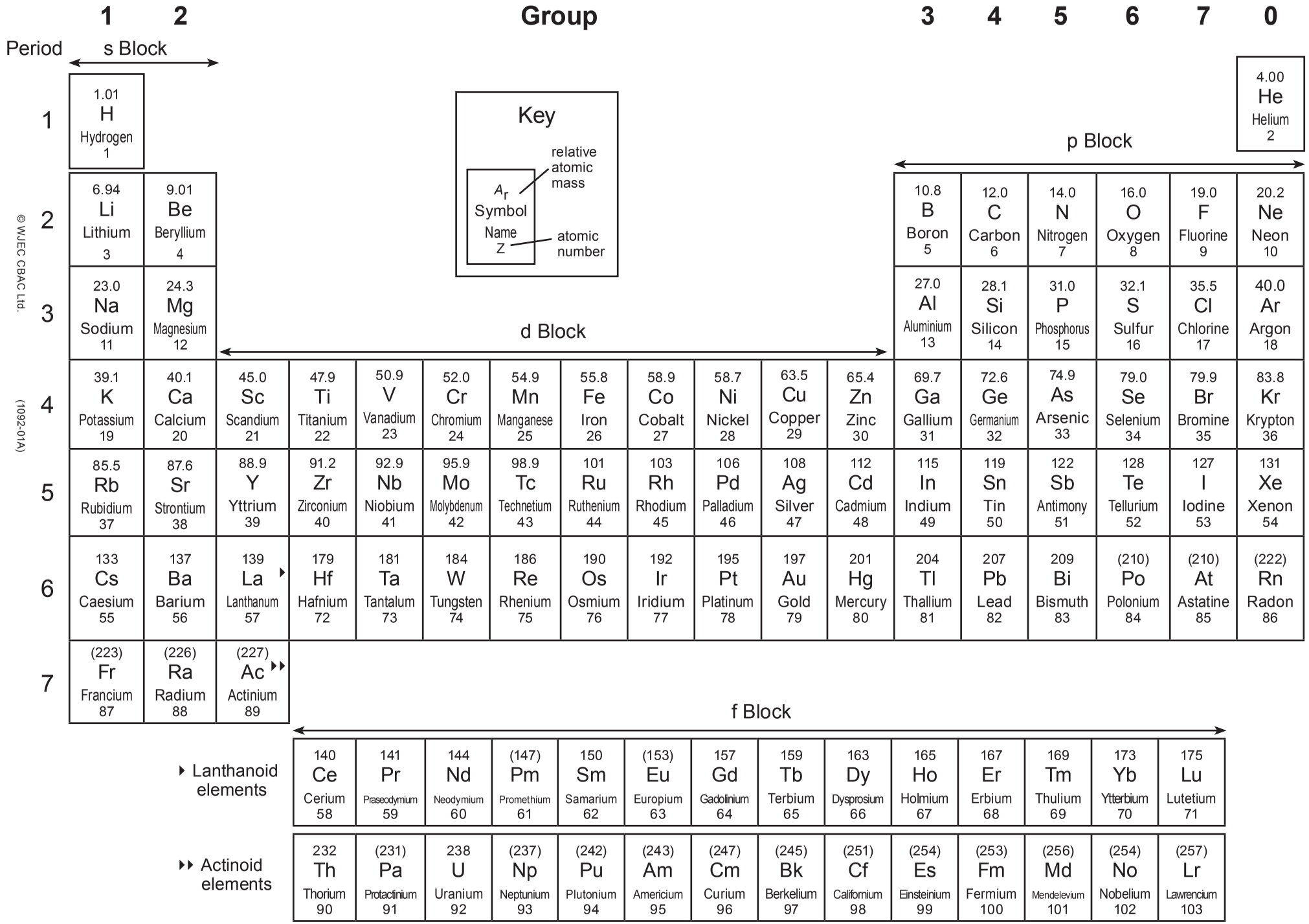
CHEMISTRY – DATA SHEET
FOR USE WITH CH2

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



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