Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

1092/01 **New AS**

CHEMISTRY CH2

A.M. WEDNESDAY, 3 June 2009

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-4	
B	5	
	6	
	7	
	8	
	9	
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

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 15 may be used for rough work.

SECTION A

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

1. Complete the table below by putting a tick (✓) in the boxes that correctly describe graphite. [1]

Conducts electricity		*Melting temperature*		*Bonding*	
Yes	No	High	Low	Covalent	Ionic

2. (i) Give the equation for the reaction of barium metal with water. [1]

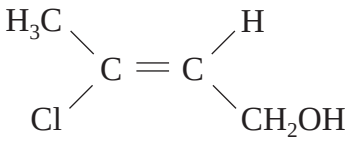
.....

(ii) The solution obtained in (i) contains barium ions.
State a reagent that would be added to this solution to show the presence of barium ions, giving the result of the test.

Reagent ..... [1]

Observation ..... [1]

3. (i) Explain why Compound **T** has E-Z (trans-cis) isomers. [1]

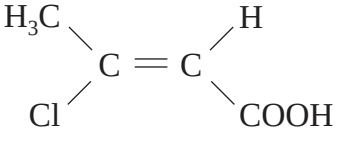


Compound **T**

.....

.....

(ii) State a reagent, used in acid solution, that reacts with Compound **T** to give Compound **Y**.[1]



Compound **Y**

.....

Examiner only

(iii) State the **type** of reaction occurring in part (ii). [1]

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(iv) The empirical formula of a substance is $C_4H_5ClO_2$.
State what additional information is needed so that its molecular formula can be found. [1]

.....

4. There is continued debate about the safety of adding fluoride ions to drinking water.

(i) Give the **ionic** half equation for the formation of fluoride ions from fluorine gas. [1]

.....

(ii) Explain why there is a strong tendency for fluorine to form fluoride ions. [1]

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.....

Section A Total [10]

Examiner only

SECTION B

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

5. *(a)* The Solvay process is used to make sodium compounds from sodium chloride.

(i) The first step in the process requires ammonia, which can be made by reacting ammonium chloride with calcium hydroxide, as shown in the equation below.

$$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + 2H_2O + 2NH_3$$

molar masses	2×53.5 g	74 g	111 g	2×18 g	2×17 g

Calculate the atom economy of this reaction where ammonia is the required product.

$$\text{atom economy} = \frac{\text{theoretical mass of required products} \times 100}{\text{total mass of reactants used}} \%$$

[2]

.....

.....

(ii) A disadvantage of the Solvay process is that the chloride ions from the sodium chloride are converted into calcium chloride, for which there has been little demand. However, recently, concentrated aqueous solutions of calcium chloride have been used in the oil industry.
A typical solution contains 45 g of calcium chloride in 100 cm^3 of solution.
Use the molar mass of calcium chloride, given in (i), to calculate the concentration of this solution in mol dm^{-3}. [2]

.....

.....

..... mol dm^{-3}

(iii) Give the equation for the reaction of calcium metal with hydrochloric acid to give calcium chloride as one of the products. [1]

.....

(iv) Calcium ions can be identified in a solution of calcium chloride by a flame test.
State the colour of the flame obtained. [1]

.....

(v) Describe how you would test for the presence of chloride ions in a solution of calcium chloride, giving the reagent used and an observation.

Reagent ..... [1]

Observation ..... [1]

(vi) Calcium chloride is an ionic compound.
Draw a dot and cross diagram for this compound, showing the outer electrons for both calcium and chlorine atoms, the outer electrons for each ion and any charges produced. [2]

(vii) Anhydrous calcium chloride, $CaCl_2$, can be used as a drying agent for some organic liquids. During this process, hydrated calcium chloride, $CaCl_2.2H_2O$, is formed.

$$CaCl_2(s) + 2H_2O \longrightarrow CaCl_2.2H_2O$$

M_r 111

In a drying process, 5.55 g of anhydrous calcium chloride, $CaCl_2$, was used.
Calculate how much water can be removed from the organic liquid. [2]

.....

.....

.....

(viii) Calcium chloride is unsuitable for drying ethanol as the ethanol bonds to the calcium chloride using a co-ordinate bond.

State what is meant by the term **co-ordinate** bond. [1]

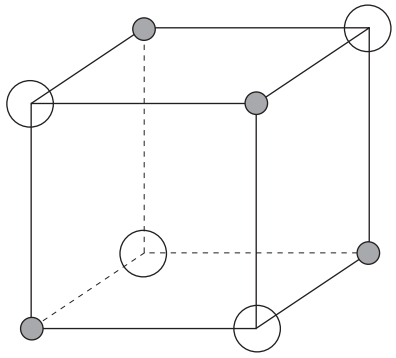
.....

.....

Total [13]

Examiner only

6. *(a)* The following diagram shows the crystal structure of sodium chloride.



(i) Write the formula of the species represented as

● ..... , ○ ..... . [1]

(ii) State the crystal co-ordination numbers for sodium chloride. ..... [1]

(iii) State the crystal co-ordination numbers for caesium chloride and explain why these are different from those of sodium chloride. [2]

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Examiner only

(b) (i) Explain why sodium chloride is soluble in water. [2]

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.....

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(ii) A student was finding the solubility of sodium chloride in water.
He heated a saturated solution of sodium chloride to dryness, using an evaporating basin.
The following table of results was obtained.

Mass of evaporating basin + sodium chloride solution	=	140.57 g
Mass of evaporating basin	=	72.00 g
∴ Mass of sodium chloride solution	=	g

Mass of evaporating basin + dry sodium chloride	=	90.57 g
Mass of evaporating basin	=	72.00 g
∴ Mass of dry sodium chloride	=	g

I. Calculate and record the missing values in the table of results. [1]

II. State the mass of water in the sodium chloride solution ..... g [1]

III. Calculate the solubility of sodium chloride in water in g / 100 g of water.

.....

.....

Solubility = ... g / 100 g water [1]

IV. State what should have been recorded so that the solubility obtained can be compared against known values. [1]

.....

(c) State why sodium is described as an s-block element. [1]

.....

(d) Titanium metal is obtained by heating titanium(IV) chloride with sodium.

$$4Na + TiCl_4 \longrightarrow Ti + 4NaCl$$

State the oxidation number (state) of each element present and use these to explain which species has been oxidised in this reaction. [2]

.....

.....

Total [13]

Examiner only

7. *(a)* (i) Petroleum (crude oil) is largely a mixture of alkane hydrocarbons. The first stage of the refining process is fractional distillation.
State what is meant by fractional distillation. [1]

.....

.....

(ii) One of the alkane hydrocarbons has the skeletal formula shown below.

Give the molecular formula of this hydrocarbon. [1]

.....

(iii) The next stage of petroleum refining is the cracking of some fractions.
State what is meant by the term ***cracking*** and explain why this is done. [2]

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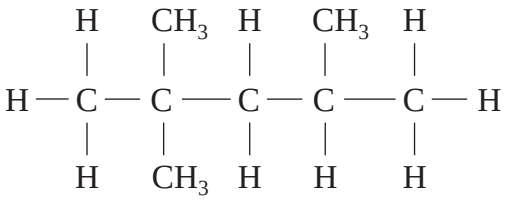
(iv) For effective combustion of petrol in motor vehicles, branched chain isomers are needed. One of these is 2, 2, 4-trimethylpentane.



Write the displayed formula (showing all the bonds) for the **straight chain isomer** of 2, 2, 4-trimethylpentane. [1]

Examiner only

(b) Dichloromethane, CH_2Cl_2, has been an important material in many paint strippers.

(i) Describe how it can be made from chloromethane and chlorine in the presence of ultraviolet light.
Your answer should include:
• the type of bond fission occurring in the initiation stage;
• a description of the initiation stage including an equation;
• **two** equations representing the propagation stage;
• an equation for the termination stage giving dichloromethane. [6]

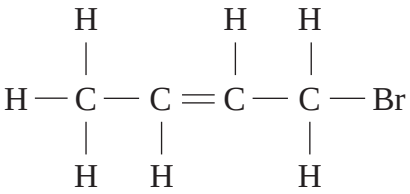
(QWC) [1]

(ii) The mass spectrum of the products obtained by making dichloromethane in (i) shows a molecular ion peak at *m/e* 98. The compound giving this molecular ion contains two ^{35}Cl atoms in each molecule.
Suggest a molecular formula and a displayed (structural) formula for this compound, explaining how it might be formed. [3]

Total [15]

Examiner only

8. *(a)* As part of a project, two students were asked to report on tests for functional groups present in the compound below.



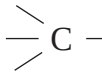
Nia reported that, in testing for the C ═ C group,

- aqueous bromine should be added to the compound and if the test is positive, the colour of the mixture changes from purple to colourless;
- the name of the compound formed in this test is 2, 3, 4-tribromobutane.

(i) Correct the two mistakes in her report.

I. ..... [1]

II. ..... [1]

David reported that, in testing for the  group,

- dilute hydrochloric acid should be added to the compound;
- aqueous silver nitrate should then be added;
- you should then see a cream precipitate that dissolves completely in dilute aqueous ammonia.

(ii) I. State what chemical should be added before adding any acid. [1]

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II. Why is it wrong to use dilute hydrochloric acid? [1]

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.....

III. State the error in the third statement. [1]

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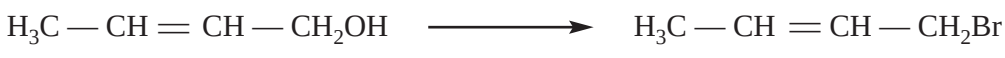
(b) 1-Bromobut-2-ene can be made from but-2-en-1-ol.



	but-2-en-1-ol	1-bromobut-2-ene
boiling temperatures / °C	121	98

(i) Use the infrared absorption frequencies given in the **Data Sheet** to explain how you would know if a sample of 1-bromobut-2-ene contains unreacted but-2-en-1-ol. [2]

.....

.....

.....

(ii) Use your understanding of intermolecular forces to explain why but-2-en-1-ol has a higher boiling temperature than 1-bromobut-2-ene.
Your answer should include:
• a description of **all** the intermolecular forces present for each compound;
• the relative strengths of the intermolecular forces present. [6]

(QWC) [2]

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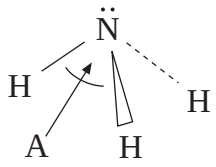
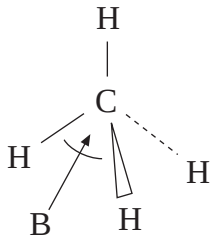
Total [15]

Examiner only

9. *(a)* (i) Explain why angle **A** in an ammonia molecule is less than angle **B** in a methane molecule. [1]





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(ii) A student wrote that *'the bonds in an ammonia molecule are not purely covalent'*. Explain why this statement is correct. [2]

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.....

(b) The d-block element, nickel, has a number of important uses.

(i) Nickel is used as the catalyst in the hydrogenation of alkenes.
Using an alkene of your choice, write an equation, using displayed formulae, for this hydrogenation, naming your product. [2]

(ii) In recent years, nickel-containing 'smart alloys' have been developed.
A particular smart alloy changes shape when a force is applied but returns to its original shape when the force is removed.
Suggest a use for this type of smart alloy. [1]

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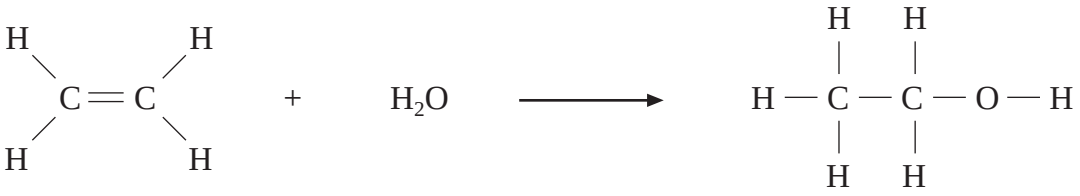
(iii) Nickel is purified using nickel tetracarbonyl, $Ni(CO)_4$.
This is a tetrahedral molecule with the same shape as methane.

State the bond angle in such tetrahedral molecules. ..... [1]

(c) The industrial preparation of ethanol from ethene is carried out at 300 °C in the presence of a catalyst.



(i) State the pressure used in this process ..... [1]

(ii) The **reverse** process is carried out by passing ethanol vapour over a catalyst.

I. State a catalyst that can be used ..... [1]

II. State the type of reaction that is occurring in this **reverse** process. [1]

.....

(d) (i) 1, 1, 1-Trifluoro-2-bromo-2-chloroethane (halothane) is used as a general anaesthetic. Write the displayed formula for this compound. [1]

(ii) State another use for halogenoalkanes. [1]

.....

(iii) One disadvantage of some halogenoalkanes, the CFCs, is that they cause damage to the ozone layer.
The table shows the relative ozone depletion potential (RODP) of some CFCs, taking CCl_3F as having a value of 1.0.

Compound	RODP
CHF_3	0.01
$CHC1F_2$	0.05
CCl_2F_2	0.86
CCl_3F	1.00
$CBrClF_2$	10.00

The carbon-halogen bond energies are shown below.

Bond	*Average bond enthalpy* / kJ mol^{-1}
C—Br	276
C—Cl	338
C—F	484

Use both tables to comment on how the C—halogen bond energies, and the number and type of halogen atoms per molecule, are related to their destructive effects on the ozone layer. [2]

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Total [14]

Section B Total [70]

Examiner only

Rough Work