Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced Subsidiary/Advanced

WJEC CBAC

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch Gyfrannol/Uwch

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-6	
B	7	
	8	
	9	
	10	
TOTAL MARK		

331/01

CHEMISTRY CH1

A.M. WEDNESDAY, 11 January 2006

(1 hour 30 minutes)

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- copy of the **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 (56 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 66.

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 14 may be used for rough work.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

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

1. State which **one** of the following always gives the number of neutrons present in an atom.

A Number of protons plus number of electrons.
B Mass number minus atomic number.
C Relative atomic mass minus number of protons.
D Number of charged particles minus the number of electrons. [1]

2. Complete the following table by inserting "good" or "poor" in the empty boxes as appropriate. [2]

	Solubility in water	*Electrical conductivity*
Graphite		Good
Iodine crystals	Poor	
Ethanol		Poor
Copper	Poor	

3. *(a)* Sketch the electron density distribution in a hydrogen molecule, H_2, in the space below. [1]

(b) State the main **difference(s)** between this H_2 molecular electron density distribution and that in two separate hydrogen atoms. [1]

4. *(a)* State the shape of a gaseous BF_3 molecule and the $\widehat{FBF}$ bond angle.

Shape .....

Bond angle ..... [2]

(b) Explain why a gaseous PF_3 molecule would not have the same shape as the BF_3 molecule. [1]

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5. Hydrated ammonium iron(III) sulphate has the formula $NH_4Fe(SO_4)_2.12H_2O$
Calculate the number of moles of each of the following species present in 0·5 moles of hydrated ammonium iron(III) sulphate.

Water molecules ..... mol

Oxygen atoms ..... mol [1]

6. State which **one** of the following statements about metallic bonding in a solid is **not** correct.

A The solid contains a regular arrangement of cations but no anions.
B Outer electrons are delocalised throughout the solid.
C It is a form of intermolecular bonding.
D It gives rise to high electrical conductivity.

..... is not correct. [1]

Section A Total [10]

Turn over.

SECTION B

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

7. *(a)* The energy changes for the ionisation of gaseous calcium, magnesium and potassium atoms by the removal of **two** electrons,

$$X(g) \longrightarrow X^{2+}(g) + 2e^{-}$$

are shown in the table below.

X	*Energy to remove 2 electrons* / kJ mol^{-1}
Ca	1735
Mg	2189
K	3470

Explain, in terms of the electronic structures of the atoms concerned, why

(i) the energy needed to remove two electrons from Ca is less than for Mg, [2]

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(ii) the energy needed to remove two electrons from K is much greater than for Ca. [2]

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(b) One radioactive isotope of potassium, $^{40}_{19}\mathrm{K}$, occurs naturally **at low concentration** and contributes to the "background radioactivity" present in the environment.

(i) If $^{40}_{19}\mathrm{K}$ decays by β emission, give the mass number and symbol of the product atom. [1]

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(ii) Outline why radioactivity may be a health hazard. [2]

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(iii) The half-life for $^{40}_{19}\mathrm{K}$ is $1{\cdot}3 \times 10^{9}$ years.

I. Explain why, despite it being radioactive, the presence of $^{40}_{19}\mathrm{K}$ in the environment presents a negligible risk to health. [2]

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II. Determine the time which must elapse for the radioactivity of a sample of $^{40}_{19}\mathrm{K}$ to fall to 25% of its initial value. [1]

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(c) By means of diagram(s) and/or written explanations, and using the hydrogen fluoride molecule, H-F, as the example, show the meaning of the terms **dipole** and **hydrogen bonding**. [4]

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Total [14]

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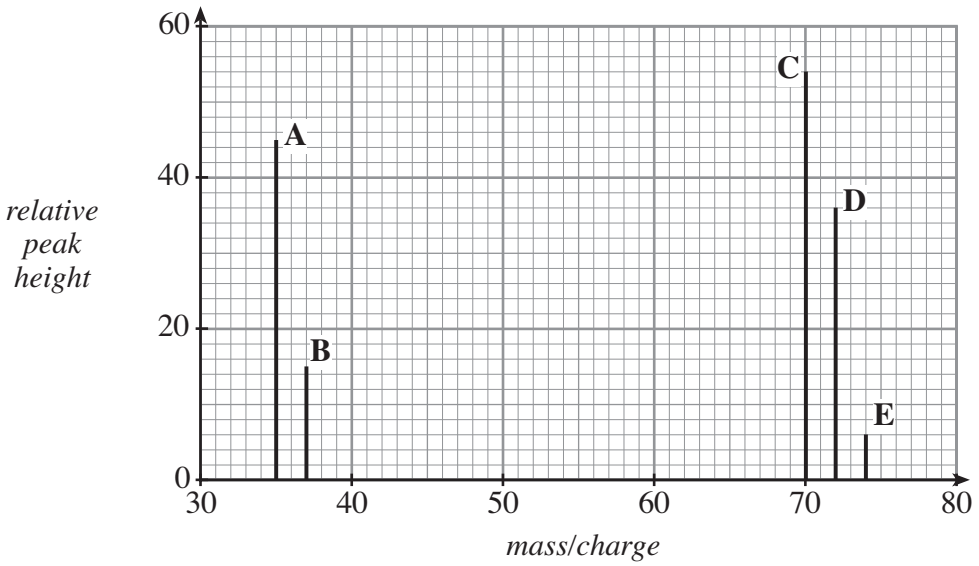
Turn over.

8. *(a)* The mass spectrum of a sample of chlorine gas, Cl_2, is shown below.



Peaks **A** and **B** are produced when the covalent bond in Cl_2 is broken *(fragmentation)*, whilst peaks **C**, **D** and **E** are *molecular ion* peaks.

(i) State the mass numbers of the isotopes of chlorine present if Cl^+ ions are responsible for peaks **A** and **B**. [1]

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(ii) Using the peaks **A** and **B**, calculate the percentage abundance of the lighter isotope. [2]

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(iii) Explain why there are three different molecular ion peaks and give the species in the mass spectrometer responsible for each of the peaks, **C**, **D** and **E**. [3]

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(b) (i) Balance the following equation, which represents a reaction that occurs between chlorine and water. [1]

$$Cl_2 + H_2O \longrightarrow HCl + O_2$$

(ii) Complete the following table to show the changes in oxidation state (number) which occur during the above reaction. [2]

Species	*Starting Oxidation State (Number)*	*Finishing Oxidation State (Number)*
Cl		
H		
O		

(iii) Showing your reasoning, use the oxidation states (numbers) in your table to identify the oxidising agent in the reaction. [1]

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(iv) Write a balanced equation for another reaction which occurs when chlorine, Cl_2, is added to water. [1]

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(c) For the Group VII halogens, chlorine (Cl_2), bromine (Br_2) and iodine (I_2),

(i) state how the oxidising power changes down the group, [1]

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(ii) explain why the elements become less volatile down the group. [2]

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Total [14]

9. This question concerns the oxides and chlorides of the elements in the Periodic Table from sodium to phosphorus, listed in the table below, together with their melting or sublimation temperatures.

Oxide	*Melting Temperature* / K	*Chloride*	*Melting Temperature* / K
Sodium oxide	1548 (sublimes)	Sodium chloride	1074
Magnesium oxide	3125	Magnesium chloride	987
Aluminium oxide	2345	Aluminium chloride	451 (sublimes)
Silicon(IV) oxide	1883	Silicon(IV) chloride	203
Phosphorus(V) oxide	573 (sublimes)	Phosphorus(V) chloride	435 (sublimes)

(a) From the ten compounds listed,

(i) give the **formulae** of **two** oxides with ionic bonding, [2]

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(ii) name **one** chloride which dissolves in excess water to produce a neutral solution. [1]

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(iii) name **two** chlorides which react with excess water to form acidic solutions. [1]

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(b) Give the **full** sub-shell electron configurations for the oxide anion and the cation in **one** of the oxides you have chosen in *(a)*(i). [2]

Oxide anion .....

Cation .....

(c) Explain why the melting temperature of silicon(IV) oxide is much higher than that of silicon(IV) chloride, even though both are covalent compounds. [2]

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(d) There is a decrease in melting temperature for the series of chlorides from sodium chloride to silicon(IV) chloride. Explain this trend. [2]

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(e) (i) Describe, by a diagram or otherwise, the crystal structure of sodium chloride. Include in your answer the crystal coordination numbers. [3]

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(ii) Magnesium oxide has the same crystal structure and coordination numbers as sodium chloride, but magnesium chloride has a different structure. Give **one** reason why magnesium chloride cannot have the same crystal structure as the other two. [1]

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Total [14]

Turn over.

10. *(a)* (i) Calculate the molar mass of calcium nitrate, $Ca(NO_3)_2$.

.....

..... Molar mass = ... g mol^{-1} [1]

(ii) Calcium nitrate exists as a **hydrate** of formula $Ca(NO_3)_2.xH_2O$.

Given that the molar mass of calcium nitrate **hydrate** is 236·1 g mol^{-1}, calculate the value of x in the formula above. [2]

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(b) Calcium nitrate crystals are deliquescent, absorbing moisture from the atmosphere to eventually give a colourless solution.

(i) Give one test, and the expected result(s), which could be used to show the presence of calcium ions in the solution. [2]

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(ii) Give the observation(s), if any, and a balanced equation for any reaction which occurs, when the aqueous solution formed from the deliquescent calcium nitrate (containing calcium ions) is mixed with

I. excess sodium hydroxide solution, [2]

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II. dilute sodium hydrogencarbonate solution. [1]

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(iii) The bonding in calcium nitrate is ionic, with Ca^{2+} and NO_3^- ions present. Using a diagram, or otherwise, explain how the ions interact with water when forming a solution. [2]

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(c) Calcium nitrate decomposes on heating according to the equation

$$2Ca(NO_3)_2(s) \longrightarrow 2CaO(s) + 4NO_2(g) + O_2(g)$$

(i) State how many moles of gas would be produced by the complete decomposition of 1 mole of calcium nitrate. [1]

.....

(ii) Calculate the maximum volume that the amount of gas produced in *(c)*(i) would occupy at a temperature of 150 °C and 1 atm pressure. [2]

(1 mole of gas occupies 24·0 dm^3 at a temperature of 25 °C and 1 atm pressure.)

.....

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(d) Name **one** calcium compound which is important in bones and skeletons. [1]

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Total [14]

Rough Work