Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

331/01

CHEMISTRY CH1

A.M. WEDNESDAY, 4 June 2008

1½ hours

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1-7	
B	8	
	9	
	10	
	11	
TOTAL MARK		

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 16 may be used for rough work.

SECTION A

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

1. State the number of **protons** in a Ca^{2+} ion. [1]

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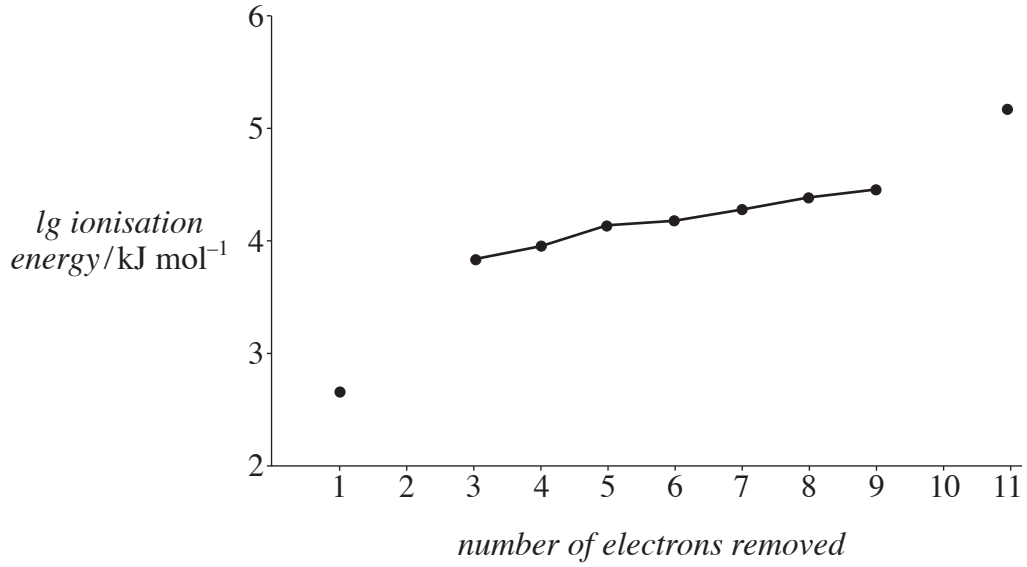
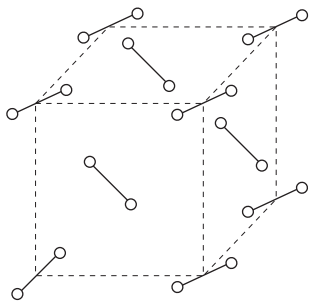
2. The diagram shows the ionisation energies to successively remove all eleven electrons from a sodium atom. Complete the graph by filling in, with dots, the missing points for removing the second and tenth electrons and connecting them to their neighbouring points.



[2]

3. State which of the following solids is represented by the diagram below:



A caesium chloride;
B diamond;
C iodine;
D silicon dioxide. [1]

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4. *(a)* Define the ***mole***. [1]

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.....

(b) State which **one** of the following is the number of moles of aluminium ions, Al^{3+}, in 0·30 moles of aluminium oxide, Al_2O_3:

A 0·10;
B 0·15;
C 0·60;
D 0·90. [1]

.....

5. State which **one** of the following letters represents the **weakest** type of bonding:

A covalent;
B hydrogen;
C ionic;
D metallic. [1]

.....

6. Describe the shape of a ***p-orbital***. [1]

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7. *(a)* Explain the term ***electronegativity***. [1]

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(b) The table gives some electronegativity values.

Atom	A1	Be	H	Mg	N	S
Electronegativity	1·61	1·57	2·20	1·31	3·04	2·59

Select the two atoms from the list which would give the **most polar bond** when combined. [1]

.....

Section A Total [10]

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SECTION B

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

8. In November 2006 a Russian, Alexander Litvinenko, was killed in London, apparently as a result of poisoning by a radioactive isotope of polonium, ^{210}Po.

(a) (i) ^{210}Po is manufactured in small amounts by bombarding ^{209}Bi with neutrons.

$$^{209}Bi + {}^{1}n \longrightarrow {}^{210}Po + X$$

Identify the product X. [1]

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(ii) ^{210}Po decays by α-emission. Give the mass number and symbol of the isotope formed when ^{210}Po decays by α-emission. [1]

Mass number ..... *Symbol* .....

(iii) ^{210}Po decays with a half life of 138 days and the maximum safe level in the body is thought to be 7 picograms. If a sample of water is contaminated with 56 picograms of ^{210}Po, calculate the minimum time that must elapse before the sample of water reaches the maximum safe level of ^{210}Po. [2]

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(iv) It is suspected the ^{210}Po was smuggled into London in a small glass container carried in luggage. Explain why there is relatively little risk due to radioactivity when the polonium is in luggage but it is lethal once taken into the body in food or drink. [2]

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(b) Polonium forms a chloride, $PoCl_4$, which is a yellow solid, volatile above 150 °C and soluble in non-polar solvents. State the type of bonding present in $PoCl_4$. [1]

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(c) When a sample of $^{210}PoCl_4$ was passed through a mass spectrometer, the spectrum showed five molecular ion peaks corresponding to masses 350, 352, 354, 356 and 358.

(i) State the two isotopes of Cl found in naturally occurring chlorine. [1]

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(ii) Each of the five molecular ions giving peaks in the mass spectrum of ^{210}Po chloride, $^{210}PoCl_4$, contains one ^{210}Po atom and four Cl atoms. Using your answer to (i), state how many atoms of each of the two Cl isotopes are present in each molecular ion. [2]

350 molecular ion .....

352 molecular ion .....

354 molecular ion .....

356 molecular ion .....

358 molecular ion .....

(iii) Explain how the positive ions produced in a mass spectrometer are **formed** and **separated**. [3]

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Total [13]

9. *(a)* The table shows some of the elements in the Periodic Table together with the melting temperature of the most important solid form of the element.

	I	II	III	IV	V	VI	VII	0
Element				C (diamond)				Ne
Melting temperature / K				3900				25
Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting temperature / K	371	922	933	1683	317	392	172	84

(i) State which of the elements shown will **not** be solids at room temperature. [1]

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(ii) Explain, in terms of bonding and structure, why silicon, Si, and carbon, C, have the highest melting temperatures. [2]

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(iii) Explain why neon, Ne, and argon, Ar, have the lowest melting temperatures. [2]

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(iv) Explain why the melting temperature increases for the sequence Na, Mg, Al, even though all three involve metallic bonding. [2]

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(v) Explain why the melting temperature for Si is lower than that for C even though they involve the same bonding and structure. [1]

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(vi) Explain why the melting temperature of argon, Ar, is higher than that for neon, Ne. [1]

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(b) Another form of carbon is graphite. Describe the bonding and structure of graphite. Your answer should include

- the different types of bonding present
- the arrangement of atoms
- how the bonding affects the electrical conductivity and other physical properties.

[4]

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Total [13]

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Turn over.

10. Crystalline barium hydroxide exists as a hydrate, $Ba(OH)_2.xH_2O$, which dissolves in water.

(a) Explain the interactions between ions and water molecules. [3]

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(b) Name a test, and the expected result, which could be used to show the presence of barium ions in the hydrate crystals. [1]

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(c) The molar mass of barium hydroxide hydrate, $Ba(OH)_2.xH_2O$, is 315·46 g mol^{-1}.

(i) After removal of all the water molecules, the molar mass drops to 171·30 g mol^{-1}. Calculate the value of x in the formula $Ba(OH)_2.xH_2O$. [2]

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(ii) Barium hydroxide hydrate has a solubility of 5·60 g per 100 cm^3 water at room temperature. Calculate, to **three** significant figures, the solubility of barium hydroxide in mol dm^{-3}. [2]

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(iii) Giving your reason(s), state whether calcium hydroxide will have a higher or lower solubility than barium hydroxide. [1]

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(d) (i) Explain the term ***oxidising agent***. [1]

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(ii) State, giving a reason, whether chlorine, Cl_2, is a stronger or weaker oxidising agent than bromine, Br_2. [1]

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(iii) Write an equation for the reaction of chlorine with water and, by allocating oxidation numbers, explain why this reaction is a redox reaction. [3]

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(iv) Outline a test, and the expected observations, to show the presence of chloride ions, Cl^-, in an aqueous solution. [2]

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Total [16]

11. This question is concerned with some compounds of phosphorus, P, atomic number 15.

(a) State the full electron sub-shell configuration for an atom of phosphorus. [1]

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(b) The molecular formula of phosphorus(V) oxide is P_4O_{10}.

(i) State the empirical formula of phosphorus(V) oxide. [1]

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(ii) State the bonding and structural type present in solid P_4O_{10}. [1]

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(c) Phosphorus(V) oxide is used as a desiccating agent to remove water because of the reaction shown below.

$$P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$$

(i) Calculate the molar mass (g mol^{-1}) of phosphorus(V) oxide. [1]

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(ii) Calculate the maximum mass of water which can be removed by reacting with 28·4g of phosphorus(V) oxide. [2]

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(d) Phosphoric(V) acid, H_3PO_4, produced when phosphorus(V) oxide reacts with water, is an important chemical with uses ranging widely from "cola" drinks to rust remover. Its salts, such as calcium phosphate, are also important.

(i) Write the formula for calcium phosphate. [1]

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(ii) Give **one** example of the importance of calcium phosphate. [1]

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(e) Phosphorus forms two chlorides, phosphorus(V) chloride, PCl_5 and phosphorus(III) chloride, PCl_3.

(i) Draw a dot and cross diagram to show the bonding in phosphorus(III) chloride, PCl_3, and use this diagram to explain the term ***lone pair of electrons***. [2]

Diagram

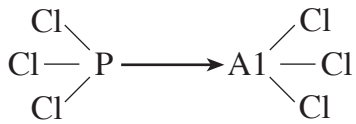
Lone pair of electrons .....

.....

(ii) Show, either by a diagram or by naming, the shapes of gaseous PCl_5 and PCl_3 molecules. [2]

PCl_5	PCl_3
shape	shape

(iii) PCl_3 reacts with aluminium chloride to form a compound



Explain the significance of the arrow in this structure. [2]

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Total [14]

Section B Total [56]

Turn over.

Rough work