

Candidate Name	Centre Number	Candidate Number
		2



## GCE AS/A level

331/01

## CHEMISTRY CH1

A.M. WEDNESDAY, 3 June 2009

1½ hours

### 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.

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

**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.

<b>A</b>	copper
<b>B</b>	graphite
<b>C</b>	iodine
<b>D</b>	sodium chloride

State which one of the above solids

(a) is the most soluble in water, [1]

.....

(b) does not conduct electricity either as a solid or when molten. [1]

.....

3. Sketch the electron density distribution in a hydrogen molecule, H<sub>2</sub>, in the space below. [1]

4. State the shape of a gaseous  $\text{BF}_3$  molecule and the value of the  $\widehat{\text{F}}\text{BF}$  bond angle. [2]

*Shape* .....

*Bond angle* .....

5. Ammonium carbonate has the formula  $(\text{NH}_4)_2\text{CO}_3$ .  
Calculate the number of moles of hydrogen atoms present in 0.5 moles of ammonium carbonate. [1]

..... moles

6. Arrange the three elements, aluminium, magnesium and sodium, in order of **increasing** strength of metallic bonding. [1]

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7. Explain the meaning of the term *hydrogen bonding*. [2]

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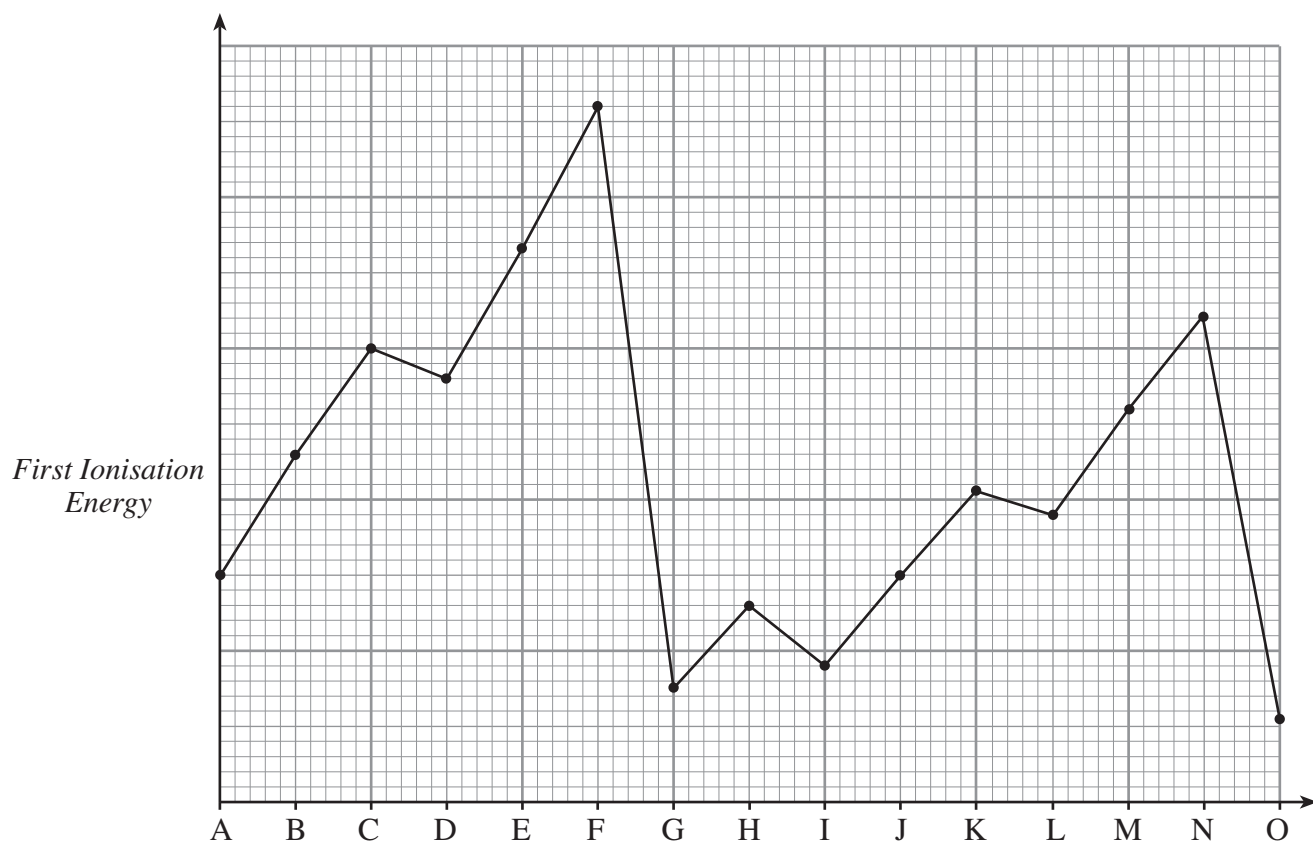
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**Section A Total [10]**

## SECTION B

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

8.



The graph shows the first ionisation energies of fifteen successive elements in the Periodic Table, lettered A to O (**which are not the chemical symbols of the elements**). All the elements have electron configurations involving only s and p orbitals.

(a) Using the letters A to O as appropriate (and **not** the chemical symbols) select:

(i) the **two** alkali metals (Group I metals); [2]

.....

(ii) the element which forms an ionic chloride of formula  $\text{XCl}_2$ ; [1]

.....

(iii) an element which forms no chemical compounds. [1]

.....

- (b) Explain why the first ionisation energy for element **I** is lower than that for element **H**. [2]

.....

.....

.....

- (c) Give the full electron subshell configuration of element **L**. [1]

.....

- (d) In 1987, thieves took and dismantled medical equipment from an abandoned clinic in Goiânia, Brazil, which contained a source of radioactive  $^{137}_{55}\text{Cs}$ . Several people died as a result of contamination with  $^{137}_{55}\text{Cs}$ .

- (i) If  $^{137}_{55}\text{Cs}$  decays by  $\beta$  emission, give the mass number and symbol of the product atom. [1]

.....

- (ii) The half-life for  $^{137}_{55}\text{Cs}$  is 30.0 years. Determine the time which must elapse for the radioactivity of a sample of  $^{137}_{55}\text{Cs}$  to fall to one-eighth of its initial value. [2]

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.....

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

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- (iv) Caesium compounds are very soluble in water. Explain why this makes radioactive caesium particularly dangerous. [1]

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- (v) Explain why the victims who died from  $^{137}_{55}\text{Cs}$  contamination were buried in lead coffins. [1]

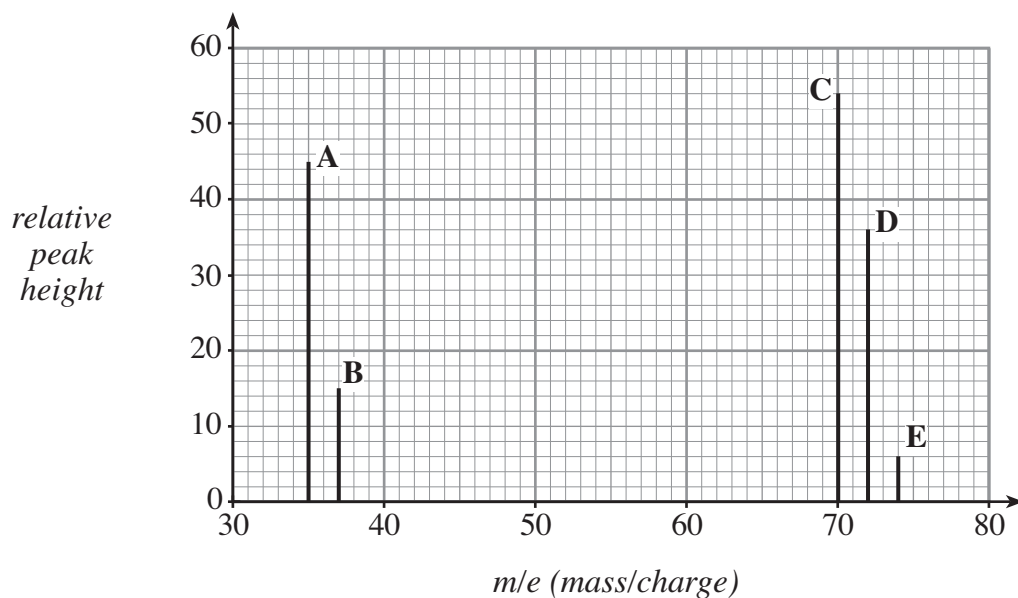
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**Total [14]**

**Turn over.**

9. (a) The mass spectrum of a sample of chlorine gas,  $\text{Cl}_2$ , is shown below.



- (i) State the mass numbers of the isotopes of chlorine present if  $\text{Cl}^+$  ions are responsible for peaks **A** and **B**. [1]
- .....
- (ii) Using the peaks **A** and **B**, calculate the percentage abundance of the lighter isotope. [2]
- .....
- .....
- .....
- (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]
- .....
- .....
- .....
- .....

- (b) (i) 6.875 g of a chloride of an element **X** would occupy a volume of 1.12 dm<sup>3</sup> as a gas at 273 K temperature and 1 atm pressure.  
Calculate the number of moles of gas present and hence the mass of 1 mole of the chloride of **X**. [2]  
(1 mole of any gas occupies 22.4 dm<sup>3</sup> at 273 K and 1 atm.)

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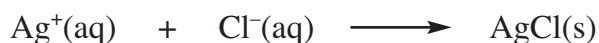
- (ii) The same 6.875 g sample of the chloride of **X** reacted vigorously with water to give an acid solution. This solution required 300 cm<sup>3</sup> of silver nitrate solution of concentration 0.500 mol dm<sup>-3</sup> to completely precipitate the chloride ions formed.

- I. Calculate the number of moles of silver nitrate used to precipitate the chloride. [1]

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- II. The ionic equation for the precipitation reaction is given below.



- Determine the number of moles of chloride ion, Cl<sup>-</sup>, precipitated. [1]

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- III. Use your answers to (b)(i) and (ii) to calculate the formula of the chloride and hence identify the element **X**. [2]

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- (c) For the Group VII halogens, chlorine (Cl<sub>2</sub>), bromine (Br<sub>2</sub>) and iodine (I<sub>2</sub>), explain why the elements become less volatile down the group. [2]

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**Total [14]**

**Turn over.**

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

<i>Oxide</i>	<i>Melting Temperature / K</i>	<i>Chloride</i>	<i>Melting Temperature / K</i>
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]

.....  
 .....

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

.....

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

.....  
 .....

(b) (i) Explain the meaning of the term *electronegativity*. [1]

.....  
 .....

(ii) Showing charges if present, draw dot and cross diagrams (outer electrons only) to show the bonding in

I. magnesium oxide, [2]

II. silicon(IV) chloride. [1]

(iii) By reference to differences in electronegativities, explain the differences in the bonding of magnesium oxide and silicon(IV) chloride. [2]

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- (c) Describe, by means of a diagram or otherwise, the crystal structure of caesium chloride. Include in your answer the crystal coordination numbers and an explanation as to why caesium chloride has a different crystal structure to sodium chloride. [4]

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**Total [14]**

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**Turn over for Q11.**

11. (a) (i) Calculate the molar mass of calcium sulphate,  $\text{CaSO}_4$ .

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

- (ii) Calcium sulphate exists as a hydrate of formula  $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$ .

Given that the molar mass of calcium sulphate hydrate is  $172.2 \text{ g mol}^{-1}$ ,  
calculate the value of  $x$  in the formula above. [2]

.....  
.....

- (b) Calcium sulphate is partially soluble in water, to 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]

.....  
.....

- (ii) Give the observation(s), if any, and an equation for any reaction which occurs,  
when an aqueous solution which contains calcium ions, is mixed with

I. excess sodium hydroxide solution, [2]

.....  
.....

II. dilute sodium hydrogencarbonate solution. [1]

.....  
.....

- (iii) At  $25^\circ\text{C}$ , a saturated calcium sulphate solution contained  $12.054 \text{ g}$  calcium  
sulphate hydrate dissolved in  $100 \text{ cm}^3$  solution. Calculate the concentration  
( $\text{mol dm}^{-3}$ ) of saturated calcium sulphate solution. [2]

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- (iv) Giving a reason, state whether the concentration ( $\text{mol dm}^{-3}$ ) of saturated barium sulphate solution would be higher or lower than that of saturated calcium sulphate solution. [1]

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- (c) (i) Write an equation for the reaction of calcium metal with water. [1]

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- (ii) By allocating appropriate oxidation numbers, show that the reaction of calcium with water is a redox reaction. [2]

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.....  
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**Total [14]**

**Section B Total [56]**

**Rough work**

A series of horizontal dotted lines for rough work.