Candidate Name	Centre Number	Candidate Number
		2

General Certificate of Education
Advanced Subsidiary/Advanced

331/01

CHEMISTRY CH1

A.M. THURSDAY, 10 January 2008
(1 hour 30 minutes)

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 15 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. A radioactive isotope of phosphorus, ^{32}P, can be used to measure the rate of phosphorus uptake in plants.
Give the mass number and the symbol of the atom formed by the emission of one β particle from an atom of ^{32}P. [1]

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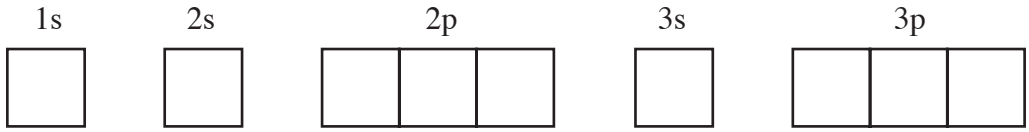
2. Calcium phosphide can be used in distress flares.
Use the convention of arrows to represent electrons to show the electronic structure of the phosphide ion, P^{3-}, found in calcium phosphide. [1]



3. State which **one** of the following correctly describes a feature of an ideal gas.

A The size of the molecules is large compared to the distance between them.

B All molecules have the same kinetic energy at a given temperature.

C The molecules slow down as the temperature increases.

D There are no attractive forces between molecules. [1]

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4. Write an equation that represents the first molar ionisation energy of potassium. [1]

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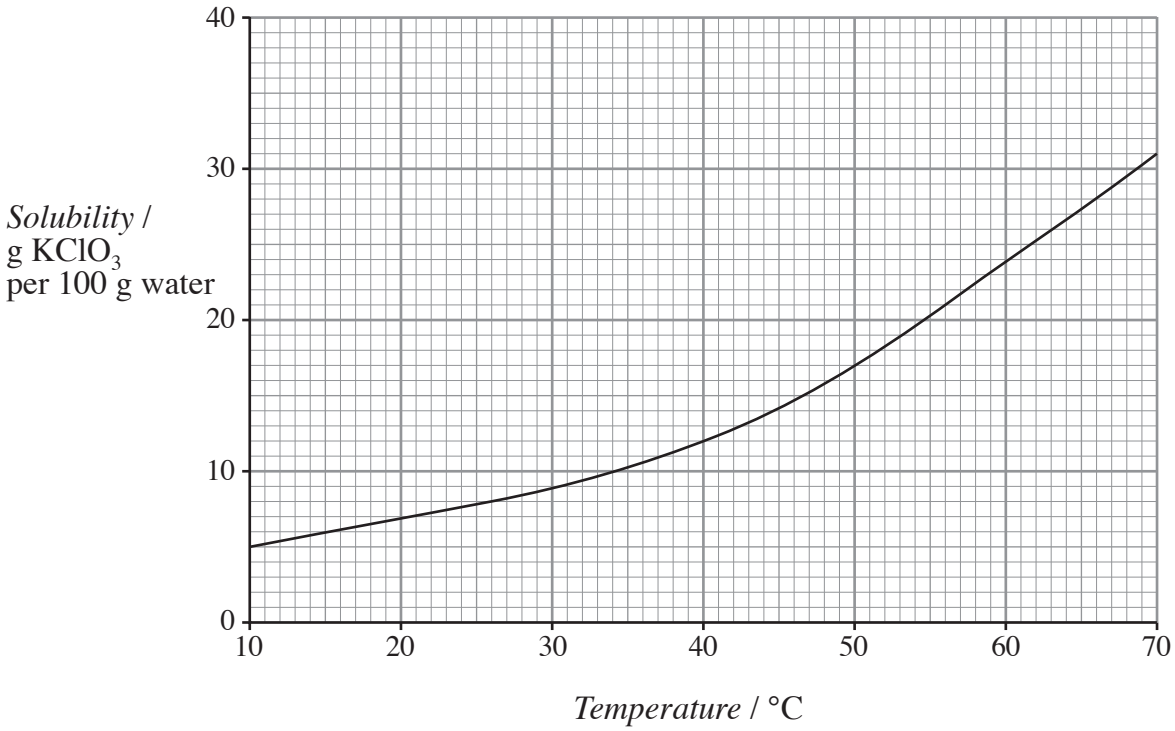
5. The graph shows the solubility of potassium chlorate(V) in water at various temperatures. A mixture containing 44 g of potassium chlorate(V) and 200 cm^3 of water was warmed. Use the graph to find the lowest temperature at which all the potassium chlorate(V) dissolved in the water. [1]



..... °C

6. State which **one** of the following gases contains the greatest number of molecules in 2·8 g.

A CO

B C_2H_4

C N_2

D HCN [1]

7. From the list of substances below,

sodium oxide diamond graphite iodine chlorine fluorine,

choose **one** which

(a) conducts electricity as a solid, ... [1]

(b) has the lowest melting temperature, ... [1]

(c) has a mass spectrum showing a peak at *m*/*z* 72, ... [1]

(d) reacts with water to give an alkaline solution. ..... [1]

Section A Total [10]

SECTION B

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

8. Lithium, Li, the lightest of all metals, was made in 1855 by the electrolysis of molten lithium chloride.

(a) A sample of lithium contains ^{6}Li 8·00% and ^{7}Li 92·0% by mass.
Calculate the relative atomic mass of lithium to three significant figures. [2]

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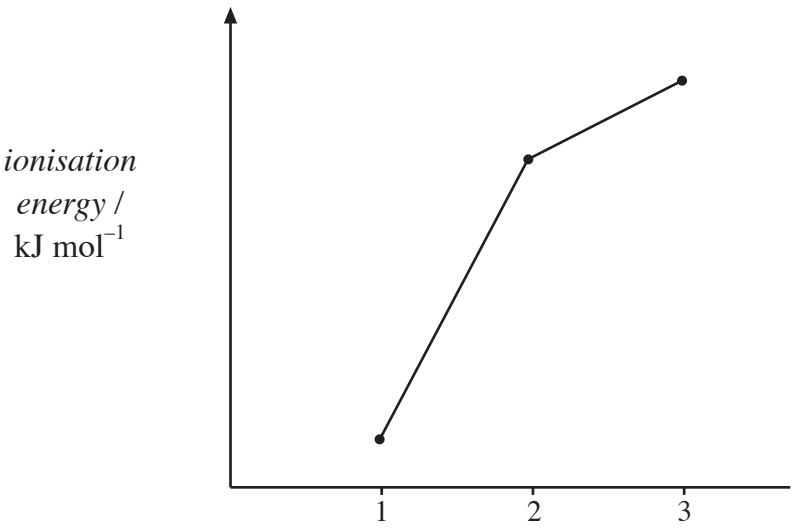
(b) The diagram below shows the successive ionisation energy values for lithium.



State the electronic structure of lithium and explain how features of the diagram support this structure. [2]

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(c) When heated in an atmosphere of hydrogen, lithium forms lithium hydride, LiH, which contains Li^+ and H^- ions.

(i) I. Write the balanced equation for the reaction between lithium and hydrogen. [1]

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II. Assign oxidation numbers (states) to the reactants and product in the equation in (i)I and use these to explain why hydrogen is acting as an oxidising agent in this reaction. [2]

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(ii) Sketch the dot and cross diagram to show the bonding present in lithium hydride. [1]

(iii) Lithium hydride has the same crystal structure as sodium chloride.
Sketch the crystal structure of lithium hydride and state the crystal co-ordination numbers of the ions. [2]

Crystal co-ordination numbers of the ions ..... and .....

(iv) Lithium hydride can be used as a source of hydrogen.
One mole of lithium hydride reacts with water to produce one mole of hydrogen gas.
Calculate the volume of hydrogen produced at room temperature and pressure, when 1 kg of lithium hydride is added to water. [2]

(One mole of hydrogen has a volume of 24·00 dm^3 at room temperature and pressure.)

..... dm^3

(d) Lithium chloride absorbs moisture from the air and has been used to remove water vapour from the air in submarines.
One species formed during this process contains co-ordinate bonds between the oxygen atoms and lithium ion.
State what is meant by the term ***co-ordinate bond*** for this ion. [1]

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(e) Lithium stearate (octadecanoate) is made by neutralising stearic acid (octadecanoic acid) with lithium hydroxide.

$$LiOH + CH_3(CH_2)_{16}COOH \longrightarrow CH_3(CH_2)_{16}COO^-Li^+ + H_2O$$

It is used as a component of low melting point greases that can be used down to –60°C. In an experiment, 0·048 mole of stearic acid was neutralised by a lithium hydroxide solution of concentration 0·64 mol dm^{-3}.
Calculate the volume of this lithium hydroxide solution needed to neutralise the 0·048 mole of stearic acid. [2]

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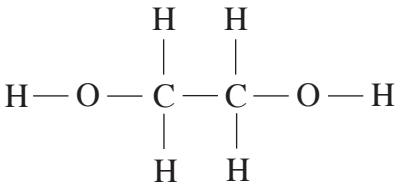
Total [15]

9. *(a)* Ethane-1, 2-diol is a viscous liquid used as an antifreeze.



(i) Write the **empirical** formula for ethane-1, 2-diol ..... [1]

(ii) Extensive hydrogen bonding occurs in ethane-1, 2-diol.
Describe what is meant by hydrogen bonding, using ethane-1, 2-diol as your example. [3]

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(iii) Antifreeze is a solution of ethane-1, 2-diol in water.
A car's cooling system contains 1240 g of ethane-1, 2-diol in a total volume of 4·54 dm^3 of antifreeze solution.
The molar mass of ethane-1, 2-diol is 62·1 g mol^{-1}.

I. Calculate the number of moles of ethane-1, 2-diol in 1240 g. [1]

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II. Calculate the concentration of ethane-1, 2-diol in the antifreeze solution. [1]

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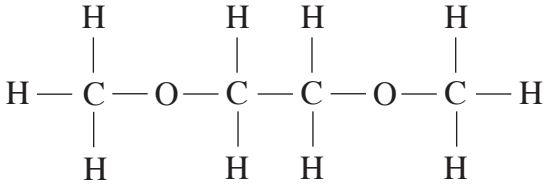
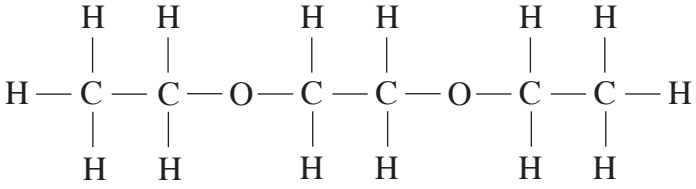
Examiner only

(b) The table shows the boiling temperatures of the two compounds 1,2-dimethoxyethane and 1,2-diethoxyethane.



1,2-dimethoxyethane



1,2-diethoxyethane

Compound	*Boiling temperature* /°C
1,2-dimethoxyethane	85
1,2-diethoxyethane	121

Explain in terms of bonding forces, why these two compounds have different boiling temperatures. [2]

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(c) Non-disposable nappies can be washed in a solution containing a mixture of compounds that kill bacteria.

A typical mixture contains the active ingredients sodium chloride and potassium peroxodisulphate, $K_2S_2O_8$. When added to water, the chloride ions present are slowly oxidised to aqueous chlorine.

$$2Cl^- + S_2O_8^{2-} \longrightarrow 2SO_4^{2-} + Cl_2$$

(i) Describe a test to show the presence of chloride ions in a solution, stating the reagent(s) and observation(s). Give an **ionic** equation for the reaction that occurs.

Reagent(s) ..... [1]

Observation(s) ..... [1]

Ionic equation ..... [1]

(ii) Describe a test to show the presence of the sulphate ions in a solution, stating the reagent(s) and observation(s).

Reagent(s) ..... [1]

Observation(s) ..... [1]

(iii) Describe what is seen when aqueous iodide ions are added to a solution which contains aqueous chlorine. Give an explanation for your observation.

Observation ..... [1]

Explanation .....

..... [1]

Total [15]

10. *(a)* Explain what is meant by the term ***lone pair of electrons***. [1]

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(b) Use your knowledge of the valence shell electron pair repulsion (VSEPR) theory to predict and explain the shape of a molecule of silicon(IV) chloride, $SiCl_4$. [2]

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(c) At room temperature, silicon(IV) chloride is a colourless liquid consisting of simple covalent molecules. Magnesium chloride is an ionic solid.

Describe and compare their

- electrical conductivity;
- volatility;
- reaction with water. [6]

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(d) Both silicon(IV) oxide and phosphorus(V) oxide are impurities present during iron production in the Blast Furnace.
These materials are removed by adding limestone, which may decompose giving calcium oxide. This then reacts with the oxides giving calcium silicate and calcium phosphate(V).

(i) Give the equation for the reaction that takes place between calcium oxide and phosphorus(V) oxide to give calcium phosphate, $Ca_3(PO_4)_2$. [2]

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(ii) These reactions are acid-base processes. Explain why some oxides react as acids and some as bases. [2]

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Total [13]

11. *(a)* Limewater is a solution of calcium hydroxide in water.
Describe a simple test to show the presence of calcium ions in this solution, stating the result of the test. [1]

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(b) Explain why limewater becomes cloudy when exposed to air. [1]

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(c) (i) Complete the table to show what is seen, if anything, when concentrated sodium hydroxide solution is added to separate solutions containing magnesium ions and barium ions. [2]

Ion	*Observation*
magnesium	
barium	

(ii) Explain your observations in (i) in terms of the relative solubilities of the compounds produced. [1]

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(d) (i) State the reactants that can be used, in each case, to produce magnesium sulphate by **two** different methods.
Give an equation for **one** of these methods. [3]

1. .....

2. .....

Equation .....

(e) A hydrated chloride of calcium has the formula $CaCl_2 . xH_2O$.
Under appropriate conditions the hydrated chloride loses water to give anhydrous calcium chloride.

$$CaCl_2 . xH_2O(s) \longrightarrow CaCl_2(s) + xH_2O(g)$$

The results of an experiment are shown below.

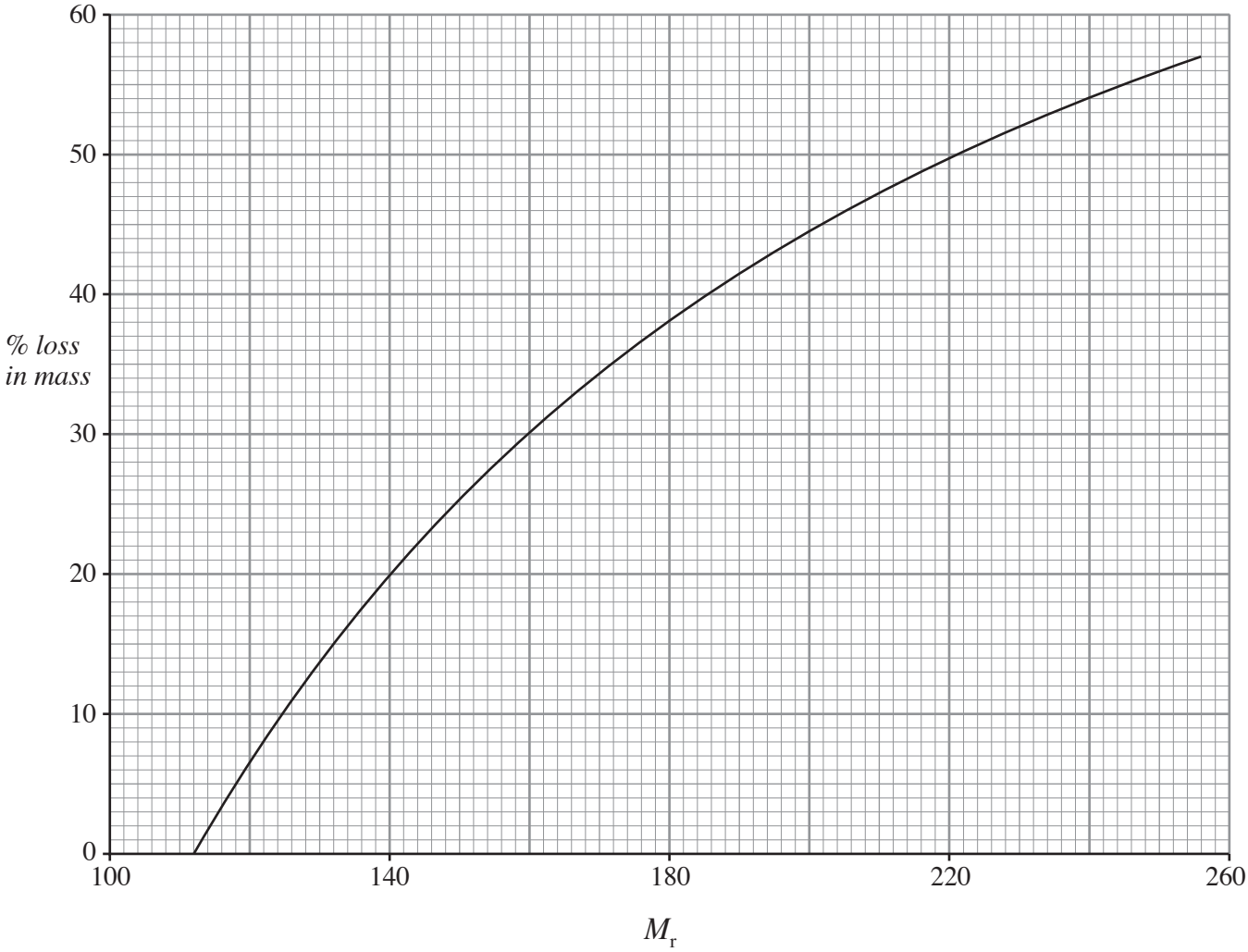
Mass of crucible + hydrated calcium chloride	=	22·93 g
Mass of crucible + anhydrous calcium chloride	=	19·15 g
Mass of crucible	=	15·27 g

(i) Use the results to find the mass of water lost. ..... g [1]

(ii) Calculate the percentage loss in mass. [1]

..... %

(iii) The graph below shows how the percentage loss in mass varies with M_r.



Use the graph to find the relative molecular mass (M_r) of the hydrated calcium chloride. [1]

M_r = ...

(iv) Use the M_r obtained in (iii) to obtain the value of x in $CaCl_2 . xH_2O$. [2]

(If you have not obtained an answer to (ii) you may assume that the relative molecular mass is 201, but this is not the correct figure).

x = ...

Total [13]

Section B Total [56]

Rough Work