THIS IS A NEW SPECIFICATION

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RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

CHEMISTRY A

Atoms, Bonds and Groups

F321

Candidates answer on the question paper

OCR Supplied Materials:
- *Data Sheet for Chemistry A* (Inserted)

Other Materials Required:
- Scientific calculator

Friday 9 January 2009
Afternoon

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **12** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	11	
2	15	
3	14	
4	8	
5	12	
TOTAL	60	

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Answer **all** the questions.

1 Carbon occurs in a wide range of compounds and is essential to living systems.

(a) Two isotopes of carbon are ^{12}C and ^{13}C.

(i) State what is meant by the term *isotopes*.

.....

..... **[1]**

(ii) Isotopes of carbon have the same chemical properties.

Explain why.

.....

..... **[1]**

(iii) The ^{12}C isotope is used as the standard measurement of relative masses.

Define the term *relative isotopic mass*.

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..... **[2]**

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(b) One form of naturally occurring carbon is graphite.

The table below lists some properties of graphite.

electrical conductivity	good conductor
hardness	soft
melting point	very high

- Describe the bonding and structure in graphite.
- Explain, in terms of bonding and structure, the properties of graphite shown above.



In your answer, you should use appropriate technical terms, spelt correctly.

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..... **[5]**

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(c) In the sixteenth century, a large deposit of graphite was discovered in the Lake District.

People at the time thought that the graphite was a form of lead.

Nowadays, graphite is used in pencils but it is still referred to as 'pencil lead'.

A student decided to investigate the number of carbon atoms in a 'pencil lead'. He found that the mass of the 'pencil lead' was 0.321 g.

(i) Calculate the amount, in mol, of carbon atoms in the student's pencil lead.

Assume that the 'pencil lead' is pure graphite.

answer = ... mol **[1]**

(ii) Using the Avogadro constant, N_A, calculate the number of carbon atoms in the student's 'pencil lead'.

number of carbon atoms = ... **[1]**

[Total: 11]

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2 Chemists have developed models for bonding and structure which are used to explain different properties.

(a) Ammonia, NH_3, is a covalent compound.

(i) Explain what is meant by a *covalent bond*.

..... **[1]**

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in NH_3.

Show **outer** electrons only.

[1]

(iii) Name the shape of the ammonia molecule.

Explain, using your '*dot-and-cross*' diagram, why ammonia has this shape and has a bond angle of 107°.

shape: .....

explanation: .....

.....

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..... **[3]**

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(b) Ammonia reacts with hydrogen chloride, HC*l*, to form ammonium chloride, NH_4Cl.

NH_4Cl is an ionic compound containing NH_4^+ and Cl^- ions.

(i) Complete the electron configuration of the Cl^- ion.

$1s^2$ ..... **[1]**

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in NH_4^+.

Show **outer** electrons only.

[1]

(iii) State the shape of, and bond angle in, an NH_4^+ ion.

shape: .....

bond angle: ..... **[2]**

(iv) A student investigated the conductivity of ammonium chloride.

She noticed that when the ammonium chloride was solid it did **not** conduct electricity. However, when ammonium chloride was dissolved in water, the resulting solution did conduct electricity.

Explain these observations.

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..... **[2]**

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(c) Ammonium compounds such as ammonium sulfate, $(NH_4)_2SO_4$, can be used as fertilisers.

(i) Write a balanced equation to show how ammonium sulfate could be formed by the reaction between aqueous ammonia and sulfuric acid.

..... **[1]**

(ii) Ammonium sulfate is an example of a salt formed when an acid is neutralised by a base.

Explain what is meant by the term *salt*.

.....

..... **[1]**

(iii) Why is ammonia acting as a base in this neutralisation?

.....

..... **[1]**

(iv) What is the relative formula mass of $(NH_4)_2SO_4$?

Give your answer to **one** decimal place.

..... **[1]**

[Total: 15]

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3 A student used the internet to research chlorine and some of its compounds.

(a) He discovered that sea water contains chloride ions. The student added aqueous silver nitrate to a sample of sea water.

(i) What would the student see?

..... **[1]**

(ii) Write an ionic equation, including state symbols, for the reaction that would occur.

..... **[2]**

(iii) After carrying out the test in **(i)**, the student added dilute aqueous ammonia to the mixture.

What would the student see?

..... **[1]**

(b) The student also discovered that chlorine, Cl_2, is used in the large-scale treatment of water.

(i) State **one** benefit of adding chlorine to water.

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..... **[1]**

(ii) Not everyone agrees that chlorine should be added to drinking water.

Suggest **one** possible hazard of adding chlorine to drinking water.

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..... **[1]**

(c) The equation for the reaction of chlorine with water is shown below.

$$Cl_2(g) + H_2O(l) \rightarrow HCl(aq) + HClO(aq)$$

(i) State the oxidation number of chlorine in:

Cl_2 ..... HCl ..... HClO ..... **[1]**

(ii) The reaction of chlorine with water is a *disproportionation* reaction.

Use the oxidation numbers in **(i)** to explain why.

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..... **[2]**

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(iii) Chlorine reacts with sodium hydroxide to form bleach in another disproportionation reaction.

Write an equation for this reaction.

..... **[1]**

(d) Two other chlorine compounds of chlorine are chlorine dioxide and chloric(V) acid.

(i) Chlorine dioxide, ClO_2, is used as a bleaching agent in both the paper and the flour industry. When dry, ClO_2 decomposes explosively to form oxygen and chlorine.

Construct an equation for the decomposition of ClO_2.

..... **[1]**

(ii) Chloric(V) acid has the following percentage composition by mass:

H, 1.20%; Cl, 42.0%; O, 56.8%.

Using this information, calculate the empirical formula of chloric(V) acid.

Show **all** of your working.

empirical formula = ... **[2]**

(iii) What does (V) represent in chloric(V) acid?

.....

..... **[1]**

[Total: 14]

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4 The table below shows the melting points and atomic radii of the elements in Period 3, Na to C*l*.

element	Na	Mg	A*l*	Si	P	S	C*l*
melting point/°C	98	639	660	1410	44	113	–101
atomic radius/pm	186	160	143	118	110	102	99

$1\,pm = 1 \times 10^{-12}\,m$

(a) (i) Explain the difference in melting point for the elements Na and Mg.

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..... **[3]**

(ii) Sulfur exists as S_8 molecules and chlorine as Cl_2 molecules. Use this information to explain the difference in their melting points.

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..... **[2]**

(b) Explain the decrease in the atomic radii across the period from Na to C*l*.

In your answer, you should use appropriate technical terms, spelt correctly.

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..... **[3]**

[Total: 8]

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5 The Group 2 element barium, Ba, is silvery white when pure but blackens when exposed to air. The blackening is due to the formation of both barium oxide and barium nitride. The nitride ion is N^{3-}.

(a) Predict the formula of:

barium oxide …… barium nitride …… **[2]**

(b) A 0.11 g sample of pure barium was added to 100 cm^3 of water.

$$Ba(s) + 2H_2O(l) \longrightarrow Ba(OH)_2(aq) + H_2(g)$$

(i) Show that 8.0×10^{-4} mol of Ba were added to the water.

[1]

(ii) Calculate the volume of hydrogen, in cm^3, produced at room temperature and pressure.

volume = ... cm^3 **[1]**

(iii) Calculate the concentration, in mol dm^{-3}, of the $Ba(OH)_2(aq)$ solution formed.

concentration = ... mol dm^{-3} **[1]**

(iv) State the approximate pH of the $Ba(OH)_2(aq)$ solution.

..... **[1]**

TURN OVER FOR QUESTION 5(c) AND 5(d)

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(c) A student repeated the experiment in **(b)** using a 0.11 g sample of barium that had blackened following exposure to the air.

Suggest why the volume of hydrogen produced would be slightly less than the volume collected using pure barium.

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..... **[1]**

(d) Describe and explain the trend, down the group, in the reactivity of the Group 2 elements with water.

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..... **[5]**

[Total: 12]

END OF QUESTION PAPER

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