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 21 May 2010
Afternoon

Duration: 1 hour

OCE/22845

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. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.

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 **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Tin mining was common practice on Dartmoor in pre-Roman times. Most of the tin extracted was mixed with copper to produce bronze.

(a) The table below shows the sub-atomic particles of an isotope of tin.

isotope	protons	neutrons	electrons
^{118}Sn			

(i) Complete the table. **[1]**

(ii) In terms of sub-atomic particles, how would atoms of ^{120}Sn differ from atoms of ^{118}Sn?

.....

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

(b) The relative atomic mass of tin is 118.7.

Define the term *relative atomic mass*.

.....

.....

.....

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

(c) A bronze-age shield found on Dartmoor contained 2.08 kg of tin.

Calculate the number of tin atoms in this bronze shield.
Give your answer to **three** significant figures.

answer = ... **[2]**

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(d) Tin ore, known as cassiterite, contains an oxide of tin. This oxide contains 78.8% tin by mass. Calculate the empirical formula of this oxide. You must show your working.

answer = ... **[2]**

[Total: 9]

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2 Chemicals called 'acids' have been known throughout history. The word acid comes from the Latin 'acidus' meaning sour. Dilute sulfuric acid, H_2SO_4, is a common laboratory acid.

(a) (i) State the formulae of two ions released when sulfuric acid is in aqueous solution.

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

(ii) A student adds a sample of solid potassium carbonate, K_2CO_3, to an excess of dilute sulfuric acid.

Describe what the student would **see** and write the equation for the reaction which takes place.

.....

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

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(b) Dilute sulfuric acid reacts with alkalis such as sodium hydroxide.

Solid sodium hydroxide is known as caustic soda. It has a household use as a drain cleaner.

A student believes a box of caustic soda has been accidentally contaminated.

- To prove this, the student dissolves 2.00 g of the impure caustic soda in water and the solution is made up to 250 cm^3.
- 25.0 cm^3 of this solution of caustic soda is neutralised by 24.60 cm^3 of 0.100 mol dm^{-3} dilute sulfuric acid.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(i) Calculate the amount, in moles, of H_2SO_4 used.

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

(ii) Determine the amount, in moles, of NaOH in the 25.0 cm^3 used.

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

(iii) Calculate the percentage, by mass, of NaOH in the impure caustic soda.

answer = ... **[3]**

[Total: 10]

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3 In an atom the electrons occupy sub-shells in order of increasing energy.

(a) Complete the table below to show the order in which the next two sub-shells are filled.

1s	2s	2p	3s	3p	4s		

increasing energy $\rightarrow$

[1]

(b) Sub-shells are made up of orbitals.

(i) What is meant by an *orbital*?

.....

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

(ii) State the total number of electrons occupying the p orbitals in one chlorine atom.

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

(c) How many electrons are there in one ion of Ca^{2+}?

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

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(d) The successive ionisation energies of aluminium are shown in the table below. Some of these ionisations involve the removal of an electron from an s sub-shell.

ionisation energy / kJ mol^{-1}	578	1817	2745	11 578	14 831	18 378	23 296	27 460	31 862	38 458	42 655
ionisation number	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th

(i) State **all** the ionisation numbers that involve the removal of an electron from s sub-shells.

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

(ii) Write the equation that represents the third ionisation energy of A*l*.
Include state symbols.

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

[Total: 8]

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4 In the Periodic Table, the chemistry of elements in a group can often be predicted from the chemistry of just one element in the group.

(a) Ions of Group 7 elements take part in displacement reactions. These reactions can be used to compare the reactivities of the elements within Group 7.

A student adds aqueous solutions of halogens to test-tubes containing solutions of halide ions. The resulting mixtures are then shaken with cyclohexane, an organic solvent.

One of the student's results is shown in the table.

experiment number	experiment details	colour seen within the organic solvent
1	addition of Cl_2(aq) to I^-(aq) ions	
2	addition of Cl_2(aq) to Br^-(aq) ions	orange
3	addition of Br_2(aq) to Cl^-(aq) ions	

(i) Complete the table to show the expected colours. **[2]**

(ii) Write the ionic equation for the reaction taking place in experiment 2.

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

(iii) These three experiments alone are unable to confirm the order of reactivity for Cl_2, Br_2 and I_2.

Suggest **one** further displacement reaction which could be carried out to confirm the order of reactivity of Cl_2, Br_2 and I_2.

.....

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

(b) Chlorine gas reacts with water as shown below.

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

(i) Using oxidation numbers, explain why this reaction is an example of disproportionation.

.....

.....

.....

.....

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

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(ii) State **one** benefit for public health, of the reaction between chlorine gas and water.

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

(c) Group 2 elements and compounds show periodic trends. One trend is shown by the effect of heat upon Group 2 carbonates.

A student carried out an experiment to find out the volume of carbon dioxide obtained by heating a weighed sample of magnesium carbonate.

The student placed a 1.47 g sample of $MgCO_3$ into a test-tube and heated it until there was no further change in mass.

The following reaction took place.

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$$

(i) What type of reaction is this?

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

(ii) What volume of CO_2, in dm^3, would have been given off when measured at room temperature and pressure?

The molar mass of $MgCO_3$ = 84.3 g mol^{-1}

answer = ...dm^3 **[2]**

(iii) The student repeated the experiment a further three times, using the same number of moles of $CaCO_3$, $SrCO_3$ and $BaCO_3$.

What trend in the behaviour of the Group 2 carbonates would be observed by the student?

.....

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

[Total: 12]

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5 This question is about elements in Period 2 of the Periodic Table.

(a) Lithium has a giant metallic structure and a boiling point of 1342 °C.

Describe, with the aid of a labelled diagram, the structure and bonding in lithium and explain why lithium has a high boiling point.

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.....

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

(b) Fluorine is a gas at room temperature and has a very low boiling point of –188 °C.

(i) Draw a '*dot-and-cross*' diagram to show the bonding in a fluorine molecule. Show the outer electrons only.

[1]

(ii) Explain why fluorine has a low boiling point.

.....

.....

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

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(c) Fluorine reacts with lithium at room temperature to form a white crystalline solid, lithium fluoride. Lithium fluoride is a good conductor of electricity when molten but not when solid.

(i) Draw a '*dot-and-cross*' diagram to show the bonding in lithium fluoride.
Show the outer electrons only.

[2]

(ii) Explain why lithium fluoride conducts electricity when molten but **not** when solid.

.....

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.....

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

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(d) Fluorine reacts with boron, B, to form the fluoride BF_3.

(i) Suggest an equation for this reaction.

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

(ii) Name the shape of, and state the bond angles in, a BF_3 molecule.

Explain why BF_3 has this shape.



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

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..... **[4]**

(e) Nitrogen can also form a fluoride, NF_3, which has a permanent dipole.

Explain why NF_3 has a permanent dipole.

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

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(f) Describe and explain the trend in atomic radii of the elements Li to F across Period 2 of the Periodic Table.



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

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..... **[4]**

[Total: 21]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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