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**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
ADVANCED SUBSIDIARY GCE**

**F321**

**CHEMISTRY A**

**Atoms, Bonds and Groups**

**FRIDAY 21 MAY 2010: Afternoon**

**DURATION: 1 hour**

**SUITABLE FOR VISUALLY IMPAIRED CANDIDATES**

**Candidates answer on the Question Paper**

**OCR SUPPLIED MATERIALS:**

***Data Sheet for Chemistry A (inserted)***

**OTHER MATERIALS REQUIRED:**


**Scientific calculator**

**READ INSTRUCTIONS OVERLEAF**

## **INSTRUCTIONS TO CANDIDATES**

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **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.**
- **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.

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 |
|-------------------|---------|----------|-----------|
| $^{118}\text{Sn}$ |         |          |           |

(i) Complete the table. [1]

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

\_\_\_\_\_  
\_\_\_\_\_ [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]

- (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]

**2 Chemicals called ‘acids’ have been known throughout history. The word acid comes from the Latin ‘acidus’ meaning sour. Dilute sulfuric acid,  $\text{H}_2\text{SO}_4$ , 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,  $\text{K}_2\text{CO}_3$ , to an excess of dilute sulfuric acid.**

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

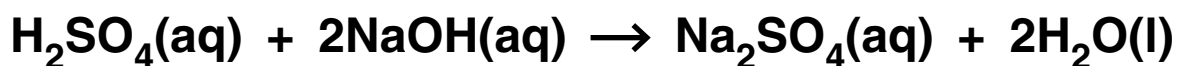
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\_\_\_\_\_ [3]

**(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<sup>3</sup>.**
- 25.0 cm<sup>3</sup> of this solution of caustic soda is neutralised by 24.60 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> dilute sulfuric acid.**



**(i) Calculate the amount, in moles, of H<sub>2</sub>SO<sub>4</sub> used.**

**answer = \_\_\_\_\_ mol [1]**

**(ii) Determine the amount, in moles, of NaOH in the 25.0 cm<sup>3</sup> used.**

**answer = \_\_\_\_\_ mol [1]**



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

**answer = \_\_\_\_\_ [3]**

**[Total: 10]**

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 →

[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  $\text{Ca}^{2+}$ ?

answer = \_\_\_\_\_ [1]

- (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<br>/ $\text{kJ mol}^{-1}$ | IONISATION<br>NUMBER |
|---|----------------------|
| 578   | 1st                  |
| 1817  | 2nd                  |
| 2745  | 3rd                  |
| 11 578                                      | 4th                  |
| 14 831                                      | 5th                  |
| 18 378                                      | 6th                  |
| 23 296                                      | 7th                  |
| 27 460                                      | 8th                  |
| 31 862                                      | 9th                  |
| 38 458                                      | 10th                 |
| 42 655                                      | 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 Al.  
Include state symbols.

\_\_\_\_\_ [2]

[Total: 8]

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 $\text{Cl}_2(\text{aq})$ to $\text{I}^-(\text{aq})$ ions  |  |
| 2                 | addition of $\text{Cl}_2(\text{aq})$ to $\text{Br}^-(\text{aq})$ ions | orange                                 |
| 3                 | addition of $\text{Br}_2(\text{aq})$ to $\text{Cl}^-(\text{aq})$ 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  $\text{Cl}_2$ ,  $\text{Br}_2$  and  $\text{I}_2$ .

Suggest ONE further displacement reaction which could be carried out to confirm the order of reactivity of  $\text{Cl}_2$ ,  $\text{Br}_2$  and  $\text{I}_2$ .

\_\_\_\_\_ [1]  
\_\_\_\_\_

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



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

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

- (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  $\text{MgCO}_3$  into a test-tube and heated it until there was no further change in mass.

The following reaction took place.



- (i) What type of reaction is this?

\_\_\_\_\_ [1]

- (ii) What volume of  $\text{CO}_2$ , in  $\text{dm}^3$ , would have been given off when measured at room temperature and pressure?

The molar mass of  $\text{MgCO}_3 = 84.3 \text{ g mol}^{-1}$

answer = \_\_\_\_\_  $\text{dm}^3$  [2]

- (iii) The student repeated the experiment a further three times, using the same number of moles of  $\text{CaCO}_3$ ,  $\text{SrCO}_3$  and  $\text{BaCO}_3$ .

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

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[1]

[Total: 12]

**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  $-188^{\circ}\text{C}$ .**

**(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.**

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**[2]**

**(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]**

(d) Fluorine reacts with boron, B, to form the fluoride  $\text{BF}_3$ .

(i) Suggest an equation for this reaction.

\_\_\_\_\_ [1]

(ii) Name the shape of, and state the bond angles in, a  $\text{BF}_3$  molecule.

Explain why  $\text{BF}_3$  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,  $\text{NF}_3$ , which has a permanent dipole.**

**Explain why  $\text{NF}_3$  has a permanent dipole.**

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**[2]**

**(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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