

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**  
**AS GCE**  
**F321/01**  
**CHEMISTRY A**  
**Atoms, Bonds and Groups**  
**FRIDAY 22 MAY 2015:**  
**Morning**  
**DURATION: 1 hour**  
**plus your additional time allowance**  
**MODIFIED ENLARGED 24pt**

<b>Candidate forename</b>						<b>Candidate surname</b>				
<b>Centre number</b>						<b>Candidate number</b>				

**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**

**The Insert will be found inside this document.**

**Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**

**Use black ink. HB pencil may be used for graphs and diagrams only.**

**Answer ALL the questions.**

**Read each question carefully. Make sure you know what you have to do before starting your answer.**

**Write your answer to each question in the space provided. If additional answer space is required, you should use the lined page 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.**

**Any blank pages are indicated.**

**BLANK PAGE**

**Answer ALL the questions.**

- 1 This question is about the elements with atomic numbers between 58 and 70.**

**(a) Cerium, atomic number 58, is a metal.**

**Complete the table to show the relative charge of each particle and the number of each particle found in a  $^{140}\text{Ce}^{2+}$  ion.**

<b>PARTICLE</b>	<b>RELATIVE CHARGE OF EACH PARTICLE</b>	<b>NUMBER OF EACH PARTICLE PRESENT IN A <math>^{140}\text{Ce}^{2+}</math> ION</b>
<b>proton</b>		
<b>neutron</b>		
<b>electron</b>		

**[2]**

**(b) Cerium behaves as a typical metal when it reacts with dilute sulfuric acid to form the salt cerium(III) sulfate and a second product.**

**(i) Identify the second product.**

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

**(ii) Write the formula of cerium(III) sulfate and, explain what has happened to the cerium in this reaction in terms of the number of electrons transferred.**

**Formula** \_\_\_\_\_

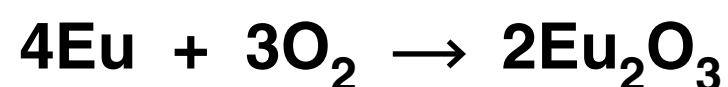
**Explanation** \_\_\_\_\_

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

**(iii) How has a salt been formed in this reaction?**

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

**(c) Europium, atomic number 63, reacts with oxygen at room temperature.**



**Calculate the volume of oxygen, in cm<sup>3</sup>, required to fully react with 9.12 g of europium at room temperature and pressure.**

**Volume = \_\_\_\_\_ cm<sup>3</sup> [2]**

**(d) A compound of thulium, atomic number 69, has the following composition by mass:**

**O 30.7%      S 15.4%      Tm 53.9%**

**(i) State what is meant by the term ‘empirical formula’.**

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

**(ii) Determine the empirical formula of the compound.**

**Show your working.**

**Empirical formula = \_\_\_\_\_ [2]**

**(e) Ytterbium, atomic number 70, is the first element in the Periodic Table to have the first four shells full.**

**(i) State the number of electrons in the FOURTH shell of ytterbium.**

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

**(ii) How many orbitals are there in the THIRD shell of ytterbium?**

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

**[TOTAL: 13]**

**2 This question is about compounds of Group 3 elements.**

**(a) Aluminium will combine directly with fluorine.**

**Write the equation for the reaction between aluminium and fluorine.**

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

**(b) Solid aluminium fluoride has a giant ionic lattice structure.**

**(i) Describe what is meant by the term ‘ionic lattice’, in terms of the type and arrangement of particles present.**

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

**(ii) Draw a ‘dot-and-cross’ diagram below for aluminium fluoride.**

**Show outer electrons only. [2]**

**(c) Solid boron tribromide has a simple molecular lattice structure. The atoms are held together by covalent bonds.**

**(i) What is meant by the term ‘covalent bond’?**

---

---

**[1]**

**(ii) Draw a ‘dot-and-cross’ diagram below to show the bonding in a boron tribromide molecule.**

**Show outer electrons only. [1]**



**(d) State whether the following substances conduct electricity when solid or molten, and explain your answers in terms of the particles involved:**

# aluminium

# aluminium fluoride

**boron tribromide.**

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

[5]

(e) Aluminium has 13 successive ionisation energies.

(i) Write the equation for the **THIRD** ionisation energy of aluminium.

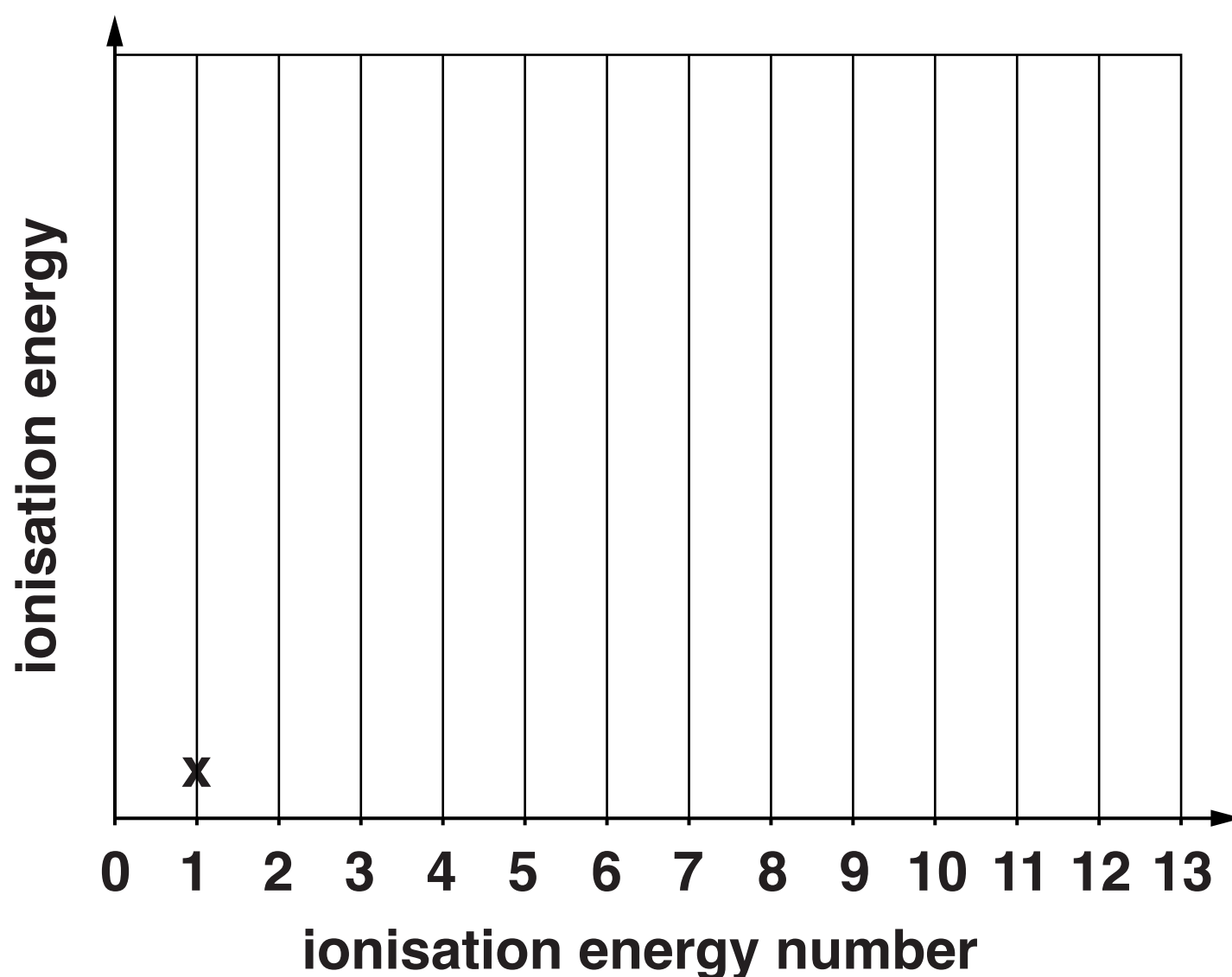
Include state symbols.

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

(ii) On the axes below, add crosses to show the 13 successive ionisation energies of aluminium.

The value for the first ionisation energy has been completed for you.

You do not have to join the crosses.



[2]

[TOTAL: 15]

**3 This question is about Group 7 elements.**

**(a) Chlorine can be made by the redox reaction below.**



**Using oxidation numbers, show what has been oxidised and what has been reduced in this reaction.**

**Oxidised** \_\_\_\_\_

\_\_\_\_\_

**Reduced** \_\_\_\_\_

\_\_\_\_\_

**[2]**

**(b) Complete the electron configuration of a manganese atom.**

**1s<sup>2</sup>** \_\_\_\_\_ **[1]**

**(c) Chlorine gas can be added to a cold, dilute alkaline solution to form bleach.**

**Write the equation for this reaction.**

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

**(d) A student bubbles chlorine gas through aqueous potassium iodide. A reaction takes place.**

**(i) State what the student would observe.**

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

**(ii) Write the ionic equation for this reaction.**

**Include state symbols.**

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

**(e) Chlorine gas reacts with methane. One of the products is dichloromethane,  $\text{CH}_2\text{Cl}_2$ .**

**(i) Chlorine is more electronegative than carbon and hydrogen, which have approximately equal electronegativity values.**

**Explain what is meant by the term ‘electronegativity’.**

---

---

---

[2]

**(ii) Draw a 3-D diagram of a molecule of  $\text{CH}_2\text{Cl}_2$ .**

**Use partial charges to indicate polar bonds.**

[2]

**(iii) Explain why a  $\text{CH}_2\text{Cl}_2$  molecule is polar.**

---

---

---

[1]

- (f) Bromine has two isotopes, Br–79 and Br–81. The relative atomic mass of bromine is 79.9.

Calculate the percentage of Br–79 atoms in a sample of bromine.

Answer = \_\_\_\_\_ % [1]

[TOTAL: 12]

- 4 A student was given  $200\text{ cm}^3$  of solution X in which sodium hydroxide,  $\text{NaOH}$ , and sodium hydrogencarbonate,  $\text{NaHCO}_3$ , had BOTH been dissolved.

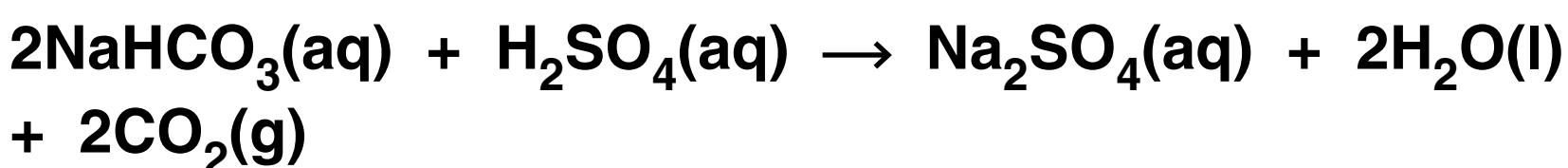
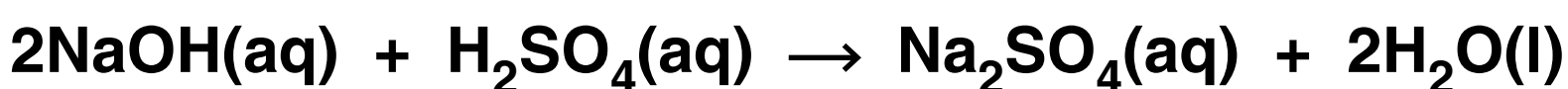
The student carried out TWO DIFFERENT titrations on samples of solution X using  $0.100\text{ mol dm}^{-3}$  sulfuric acid,  $\text{H}_2\text{SO}_4$ .

In the first titration, BOTH  $\text{NaOH}$  AND  $\text{NaHCO}_3$  were neutralised.

In the second titration, ONLY  $\text{NaOH}$  was neutralised.

The student's results for the titrations of  $25.0\text{ cm}^3$  samples of solution X are shown.

volume of $\text{H}_2\text{SO}_4$ needed to neutralise BOTH $\text{NaOH}$ AND $\text{NaHCO}_3$	$29.50\text{ cm}^3$
volume of $\text{H}_2\text{SO}_4$ needed to neutralise ONLY $\text{NaOH}$	$18.00\text{ cm}^3$



- (a) (i) Calculate the amount, in mol, of  $\text{H}_2\text{SO}_4$  used to neutralise ONLY the  $\text{NaOH}$  in  $25.0\text{ cm}^3$  of solution X.

Amount = \_\_\_\_\_ mol [1]

- (ii) Calculate the concentration, in  $\text{mol dm}^{-3}$ , of NaOH in solution X.

Concentration = \_\_\_\_\_  $\text{mol dm}^{-3}$  [1]

- (b) (i) Calculate the amount, in mol, of  $\text{NaHCO}_3$  in the  $200 \text{ cm}^3$  of solution X.

Amount = \_\_\_\_\_ mol [2]

- (ii) Calculate the mass of  $\text{NaHCO}_3$  in the  $200 \text{ cm}^3$  of solution X.

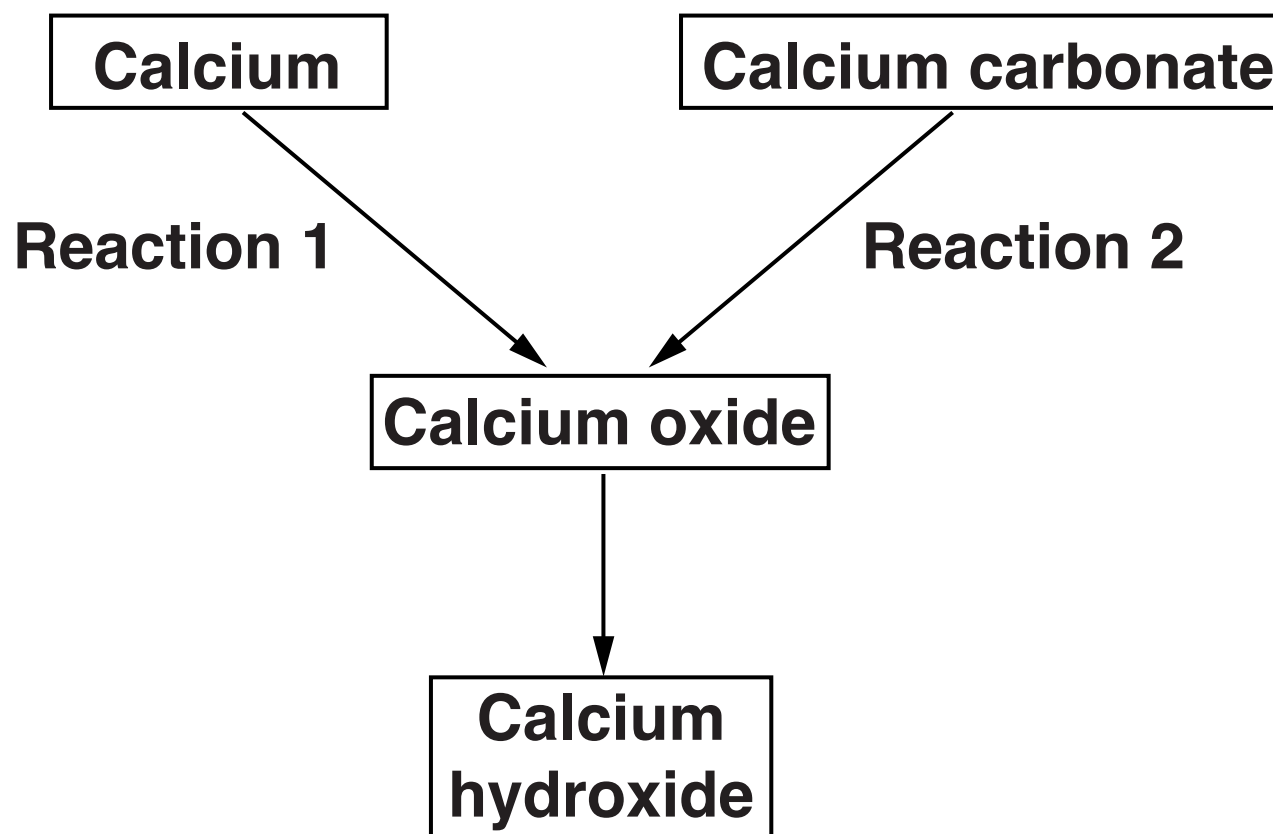
Give your answer to THREE significant figures.

Mass = \_\_\_\_\_ g [1]

[TOTAL: 5]

**5 Calcium is in Group 2 of the Periodic Table.**

**The diagram shows some reactions of calcium and its compounds.**



**(a) Reactions 1 and 2 both form calcium oxide.**

**(i) Write the equation for reaction 1.**

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

**(ii) What type of reaction is reaction 2?**

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

**(b) Calcium hydroxide is both a base and an alkali. Refer to any relevant ions in your answer.**

**Explain what is meant by the terms ‘base’ and ‘alkali’.**

**Base** \_\_\_\_\_

\_\_\_\_\_

**Alkali** \_\_\_\_\_

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



- (c) A student prepared some calcium hydroxide by adding a small piece of calcium to a large excess of water.

Describe what the student would observe and write the equation for the reaction.

Observation \_\_\_\_\_

\_\_\_\_\_

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

- (d) A student prepares a solution of calcium nitrate from calcium carbonate.

What reagent would the student need to use?

Write the equation for the reaction.

Reagent \_\_\_\_\_

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

[TOTAL: 8]

**6 This question is about the attraction between particles.**

**(a) State how and explain why the attraction between nuclei and outermost electrons in gaseous atoms varies across Period 3.**

---

---

---

---

---

---

---

[2]

**(b) The table shows the boiling points of ammonia, fluorine and bromine.**

	Boiling point/°C
ammonia, NH <sub>3</sub>	– 33
fluorine, F <sub>2</sub>	– 188
bromine, Br <sub>2</sub>	59

**Explain the different boiling points of  $\text{NH}_3$ ,  $\text{F}_2$  and  $\text{Br}_2$ .**

**Include the names of any relevant forces and particles.**

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

---

---

[illegible]

**[TOTAL: 7]**

**END OF QUESTION PAPER**

### ADDITIONAL ANSWER SPACE

**If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margins.**

[illegible]

**BLANK PAGE**

### Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

