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ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2014

Centre Number

71	
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Candidate Number

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## Chemistry

### Assessment Unit AS 1

*assessing*

Basic Concepts in Physical  
and Inorganic Chemistry

[AC112]

MONDAY 9 JUNE, AFTERNOON

ML

#### TIME

1 hour 30 minutes, plus your additional time allowance.

#### INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all fifteen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided.

Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

#### INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Quality of written communication will be assessed in Question **12(b)**.

In Section A all questions carry equal marks, i.e. **two** marks for each question.

In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A Periodic Table of the Elements, containing some data, is included in this question paper.

For Examiner's use only	
Question Number	Marks
Section A	
1-10	
Section B	
11	
12	
13	
14	
15	

<b>Total Marks</b>	
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## Section A

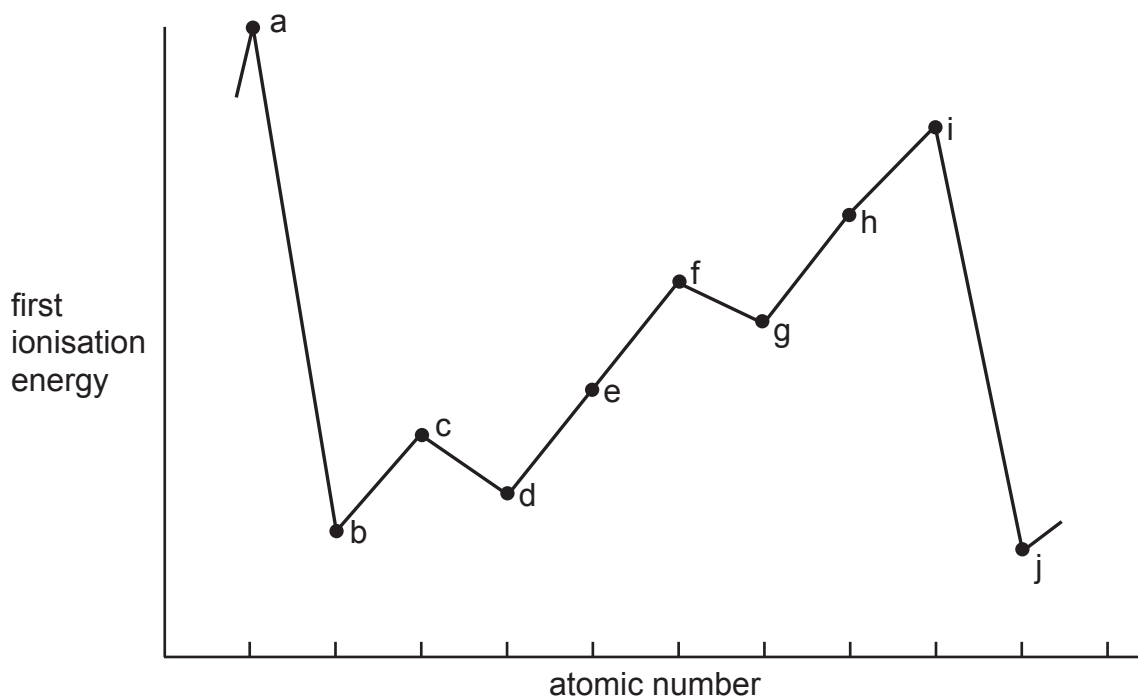
For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 Which one of the following is **not** a redox reaction?

- A  $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$
- B  $\text{Cl}_2 + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{Cl}^-$
- C  $\text{Fe} + \text{Cu}^{2+} \rightarrow \text{Fe}^{2+} + \text{Cu}$
- D  $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

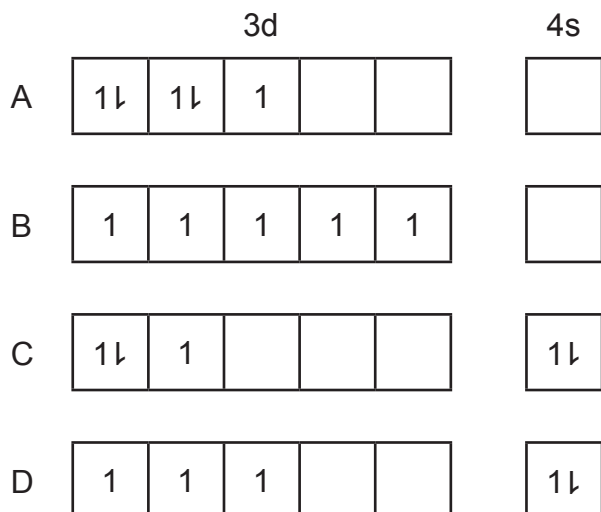
2 The graph of first ionisation energy against atomic number for a series of ten consecutive elements in the Periodic Table is shown below. Which one of the following indicates a Group II metal and a halogen?



	Group II metal	Halogen
A	a	h
B	b	g
C	c	h
D	c	i

- 3 Which one of the following is the strongest reducing agent?
- A  $F^-$
  - B  $F_2$
  - C  $I^-$
  - D  $I_2$
- 4 4.35 g of potassium sulfate is dissolved in water and made up to  $50.0\text{ cm}^3$ . Which one of the following is the concentration of potassium ions in this solution?
- A  $0.025\text{ mol dm}^{-3}$
  - B  $0.500\text{ mol dm}^{-3}$
  - C  $0.644\text{ mol dm}^{-3}$
  - D  $1.000\text{ mol dm}^{-3}$
- 5 Which one of the following describes the trend in bond energies of the halogen molecules down Group VII?
- A Decreases
  - B Decreases to bromine then increases
  - C Increases
  - D Increases to chlorine then decreases
- 6 When 0.28 g of a basic oxide,  $MO$ , is reacted with  $250\text{ cm}^3$  of  $0.05\text{ mol dm}^{-3}$  hydrochloric acid the excess acid required  $50\text{ cm}^3$  of  $0.05\text{ mol dm}^{-3}$  sodium hydroxide solution for neutralisation. Which one of the following is the relative atomic mass of  $M$ ?
- A 12
  - B 28
  - C 40
  - D 56

- 7 Which one of the following diagrams represents the distribution of electrons in the 3d and 4s subshells in the ground state of an iron(III) ion?



- 8 Which one of the following describes the reaction between solid sodium chloride and concentrated sulfuric acid?

- A Disproportionation
- B Exothermic
- C Neutralisation
- D Redox

- 9 Chlorine was bubbled through a pale green solution causing the solution to turn yellow/orange. Which one of the following ions was in the original solution?

- A  $\text{Br}^-$
- B  $\text{Fe}^{2+}$
- C  $\text{Fe}^{3+}$
- D  $\text{I}^-$

10 Which one of the following molecules does **not** contain a polar bond?

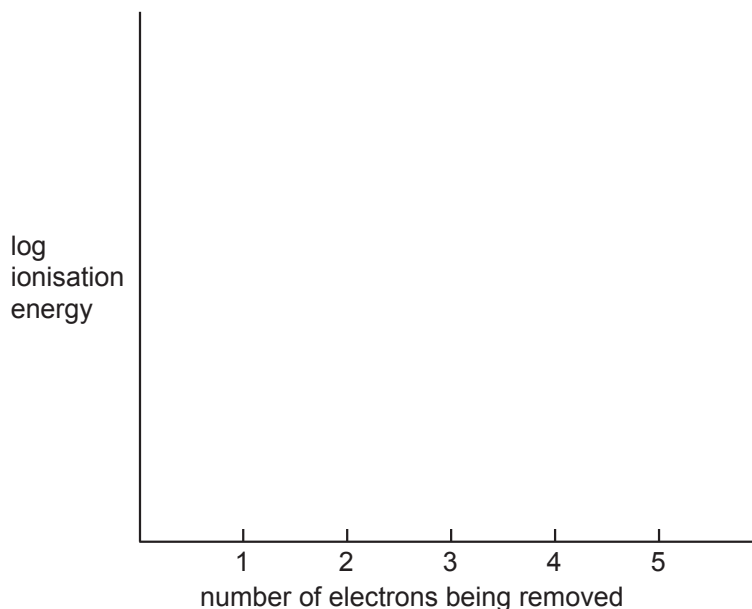
- A Fluorine
- B Hydrogen fluoride
- C Oxygen difluoride ( $\text{OF}_2$ )
- D Tetrafluoromethane ( $\text{CF}_4$ )

## Section B

Answer **all five** questions in this section.

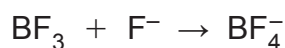
**11** Boron is the only element in Group III of the Periodic Table which is not a metal.

**(a)** On the axes below sketch a graph to show the successive ionisation energies of boron.



[3]

**(b)** Boron trifluoride can react with a fluoride ion as shown in the equation below:



**(i)** Draw a dot and cross diagram for the  $\text{BF}_4^-$  ion and use it to suggest the shape of the ion and its bond angle.

Shape \_\_\_\_\_

Bond angle \_\_\_\_\_

[4]

**(ii)** Name the type of bond formed between the fluoride ion and boron.

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

**12** Phosphorus is a non-metal with a low melting point. It reacts explosively with liquid bromine and more gently with bromine vapour. In each case phosphorus tribromide is formed.

**(a) (i)** Write an equation for the reaction of phosphorus,  $P_4$ , with bromine.

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

**(ii)** State the octet rule. Explain whether or not phosphorus obeys the octet rule in phosphorus tribromide.

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

**(b)** The melting points of silicon, phosphorus and sulfur are given in the table below.

element	Si	$P_4$	$S_8$
melting point/ $^{\circ}C$	1410	44	113

With reference to the structures of silicon and sulfur explain why each has a higher melting point than phosphorus.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [4]

Quality of written communication [2]

Examiner Only

Marks Remark

**13** Sodium is a reactive, soft, silvery metal. Chlorine is a poisonous gas. The two react together to form sodium chloride.

**(a) (i)** Using a labelled diagram explain the bonding in sodium metal.

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

**(ii)** Metals are good conductors of electricity. Explain why the electrical conductivity of aluminium is greater than that of sodium.

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

**(b) (i)** What type of structure is present in the element chlorine?

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

**(c) (i)** Draw dot and cross diagrams to show how sodium bonds with chlorine gas. Only outer shell electrons should be shown.

[3]

**(ii)** Name the type of bonding in sodium chloride.

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

Examiner Only

Marks

Remark



- (iii) The structure of sodium chloride is described as a lattice.  
Explain what is meant by the term **lattice**.

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

- (iv) Apart from its appearance give **three** physical properties of sodium chloride.

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

- (d) Sodium chloride can be made by reacting sodium carbonate with hydrochloric acid.

- (i) Write the equation for this reaction.

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

- (ii) Using the following headings calculate the mass of sodium chloride formed when 5.3 g of sodium carbonate is reacted with 0.06 dm<sup>3</sup> of 1.5 mol dm<sup>-3</sup> hydrochloric acid.

Number of moles of sodium carbonate used

\_\_\_\_\_

Number of moles of hydrochloric acid used

\_\_\_\_\_

State which reagent is in excess

\_\_\_\_\_

Number of moles of sodium chloride formed

\_\_\_\_\_

Mass of sodium chloride formed in grams

\_\_\_\_\_ [5]

Examiner Only

Marks Remark

14 Bromine tablets are used as a disinfectant in hot tubs and some swimming pools because of bromine's ability to act as an oxidising agent.

(a) Bromine reacts with water in a similar way to chlorine.

(i) Suggest the equation for the reaction of bromine with water.

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

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

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

(b) Manufacturers recommend maintaining the bromine concentration in swimming pools at 4 mg per litre. Calculate the molarity of bromine, Br<sub>2</sub>, in the water at this concentration.

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

(c) Occasionally a 'shock treatment' with chlorine is required to further disinfect the water.

(i) Suggest, in chemical terms, why chlorine is used for this purpose.

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

(ii) The compound used to provide the chlorine for the shock treatment is "sodium dichlor", NaCl<sub>2</sub>C<sub>3</sub>N<sub>3</sub>O<sub>3</sub>. Calculate the percentage of chlorine in "sodium dichlor" to **one** decimal place.

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

Examiner Only

Marks Remark

(d) Bromine is produced from the reaction of sodium bromide with concentrated sulfuric acid. Name **four** other products formed when sodium bromide reacts with concentrated sulfuric acid.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_ [4]

(e) Describe how you could show that a solution contains bromide ions.

\_\_\_\_\_

\_\_\_\_\_

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

Examiner Only

Marks Remark

- 15 (a) The first three ionisation energies of calcium are given in the table below.

1st ionisation energy	2nd ionisation energy	3rd ionisation energy
590 kJ mol <sup>-1</sup>	1145 kJ mol <sup>-1</sup>	4912 kJ mol <sup>-1</sup>

- (i) Write the equation for the second ionisation of calcium including state symbols.

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

- (ii) Using the following headings calculate the amount of energy, in kJ, required to form 8.0 g of Ca<sup>2+</sup>(g) ions from Ca(g).

Energy required to form one mole of Ca<sup>2+</sup>(g) from one mole of Ca(g)

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

Number of moles of Ca<sup>2+</sup>(g) in 8.0 g

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

Energy required to form 8.0 g of Ca<sup>2+</sup>(g)

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

- (b) The Ca<sup>2+</sup> ion has the same electron arrangement as an argon atom.

- (i) Write the electron arrangement for the Ca<sup>2+</sup> ion.

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

- (ii) The first ionisation energy of argon is 1520 kJ mol<sup>-1</sup>. Explain why the third ionisation energy of calcium is much higher than the first ionisation energy of argon.

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

Examiner Only

Marks Remark

(c) The table below shows the relative abundance of the four main isotopes of calcium.

<b>isotope</b>	$^{40}\text{Ca}$	$^{42}\text{Ca}$	$^{43}\text{Ca}$	$^{44}\text{Ca}$
<b>relative abundance</b>	96.9%	0.6%	0.2%	2.3%

(i) What is meant by **isotopes**?

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

(ii) Calculate the relative atomic mass of calcium to **two** decimal places.

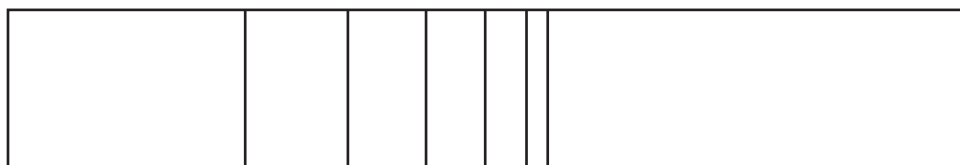
\_\_\_\_\_ [2]

(iii) Complete the following table to show the number of subatomic particles in a  $^{43}\text{Ca}$  atom.

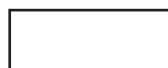
	<b>neutrons</b>	<b>electrons</b>	<b>protons</b>
$^{43}\text{Ca}$			

[2]

(d) A line emission spectrum of calcium, shown below, can be observed through a spectroscope.



frequency



(i) Draw an arrow in the box under 'frequency' pointing in the direction in which frequency increases.

[1]

Examiner Only

Marks Remark

(ii) Describe how the movement of an electron within an atom gives rise to a line in an emission spectrum.

\_\_\_\_\_

\_\_\_\_\_

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

(iii) What flame colour is observed when calcium burns?

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

(iv) Using the following headings and the first ionisation energy of calcium,  $590 \text{ kJ mol}^{-1}$ , calculate the frequency of the convergence limit of a calcium atom and state its units.

Energy, in joules, required to ionise one calcium atom

\_\_\_\_\_

\_\_\_\_\_

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

Frequency of the convergence limit of a calcium atom

\_\_\_\_\_

\_\_\_\_\_

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

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**THIS IS THE END OF THE QUESTION PAPER**

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Examiner Only

Marks Remark



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