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Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical
and Inorganic Chemistry

[AC112]

ML

MONDAY 9 JUNE, AFTERNOON

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	
Total Marks	

8844.02 ML

Section A

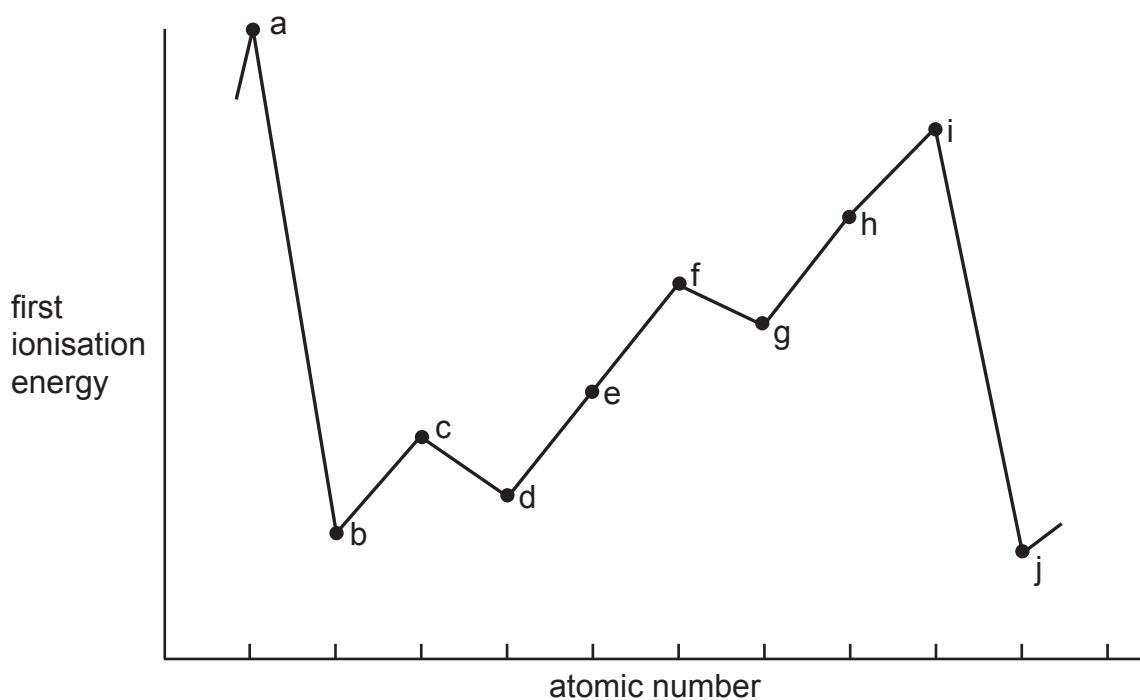
For each of the following questions only **one** of the lettered responses (A–D) is correct.

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 $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

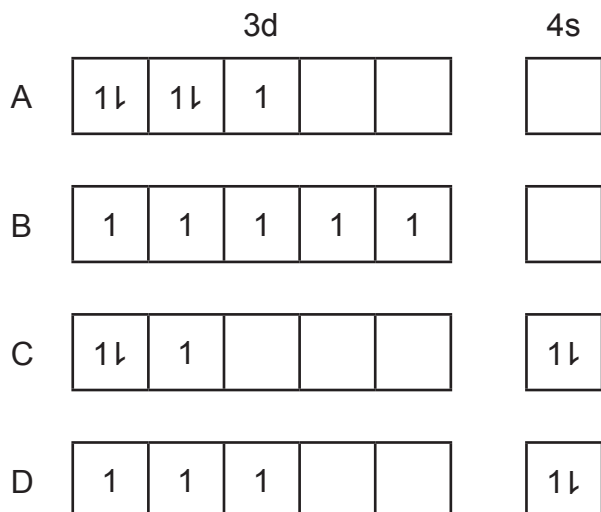
2 The graph of first ionisation energy against atomic number for a series of ten consecutive elements in the Periodic Table is shown below. Which one of the following indicates a Group II metal and a halogen?



	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 cm^3 . Which one of the following is the concentration of potassium ions in this solution?
- A 0.025 mol dm^{-3}
 - B 0.500 mol dm^{-3}
 - C 0.644 mol dm^{-3}
 - D 1.000 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 cm^3 of 0.05 mol dm^{-3} hydrochloric acid the excess acid required 50 cm^3 of 0.05 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 Br^-
- B Fe^{2+}
- C Fe^{3+}
- D I^-

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

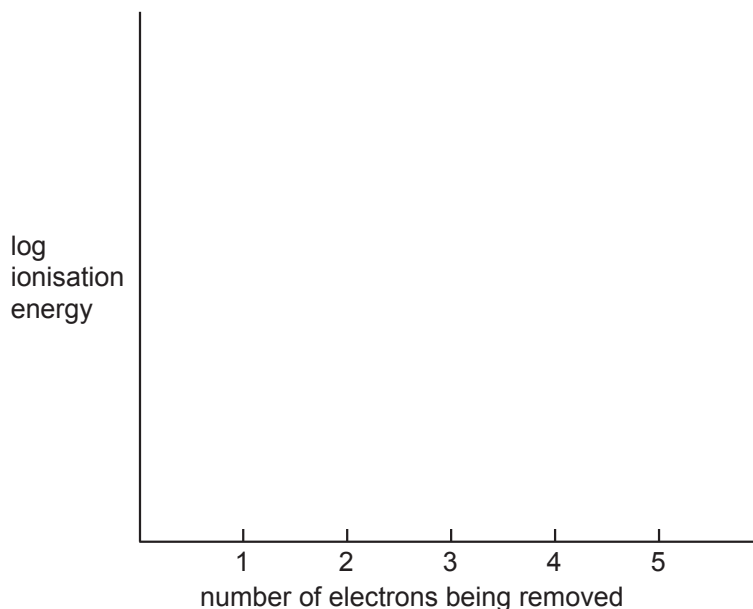
- A Fluorine
- B Hydrogen fluoride
- C Oxygen difluoride (OF_2)
- D Tetrafluoromethane (CF_4)

Section B

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

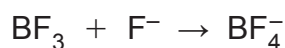
11 Boron is the only element in Group III of the Periodic Table which is not a metal.

(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 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, P₄, 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/°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]

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) 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]

- (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 dm³ of 1.5 mol dm⁻³ 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]

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, Br₂, 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", NaCl₂C₃N₃O₃. Calculate the percentage of chlorine in "sodium dichlor" to **one** decimal place.

_____ [2]

(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]

- 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 ⁻¹	1145 kJ mol ⁻¹	4912 kJ mol ⁻¹

- (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 Ca²⁺(g) ions from Ca(g).

Energy required to form one mole of Ca²⁺(g) from one mole of Ca(g)

_____ [1]

Number of moles of Ca²⁺(g) in 8.0 g

_____ [1]

Energy required to form 8.0 g of Ca²⁺(g)

_____ [1]

- (b) The Ca²⁺ ion has the same electron arrangement as an argon atom.

- (i) Write the electron arrangement for the Ca²⁺ ion.

_____ [1]

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

_____ [2]

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

isotope	^{40}Ca	^{42}Ca	^{43}Ca	^{44}Ca
relative abundance	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.

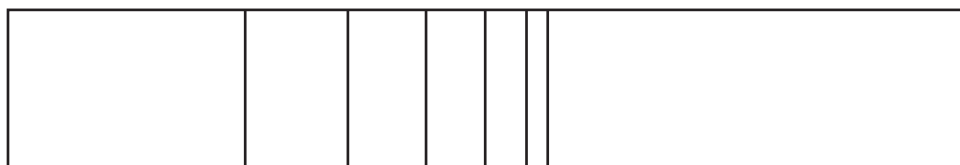
_____ [2]

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

	neutrons	electrons	protons
^{43}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]

(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 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]

THIS IS THE END OF THE QUESTION PAPER

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