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ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2017

Centre Number

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Candidate Number

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## Chemistry

Assessment Unit AS 1  
*assessing*  
Basic Concepts in Physical  
and Inorganic Chemistry

MV18

[SCH12]

FRIDAY 26 MAY, MORNING

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### 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**. **You must answer the questions in the spaces provided.**

Complete in black ink only.

## Information for Candidates

The total mark for this paper is 90.

Quality of written communication will be assessed in

Question **13(c)**.

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

In Section B the figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

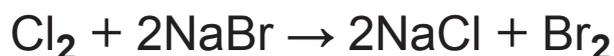
A Periodic Table of Elements, containing some data, is included with this question paper.

## Section A – Multiple Choice

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

Each multiple choice question is worth 1 mark.

1 Bromine is formed in the reaction below.



Which statement about the reaction is correct?

- A Bromide ions lose electrons
  - B Bromine is reduced by chlorine
  - C Chloride ions are reduced
  - D Chlorine is a weaker oxidising agent than bromide
- 2 Which trend in the Periodic Table is correct?
- A Boiling point decreases from fluorine to bromine
  - B First ionisation energy decreases from lithium to caesium
  - C First ionisation energy increases from nitrogen to oxygen
  - D Melting point decreases from sodium to silicon

3 Which of the following is the structure of  $^{55}\text{Mn}^{2+}$  ?

	protons	neutrons	electrons
A	25	30	23
B	25	30	27
C	27	30	25
D	30	25	28

4 Potassium iodide is formed when potassium is warmed in iodine vapour. Which of the following shows the bonding in the three species?

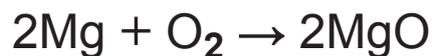
	potassium	iodine	potassium iodide
A	ionic	covalent	ionic
B	metallic	ionic	covalent
C	covalent	covalent	ionic
D	metallic	covalent	ionic

5 The element astatine lies below iodine in the Periodic Table and is likely to

- A be black.
- B be a volatile liquid at room temperature and pressure.
- C form an astatide ion,  $\text{At}^{2-}$ .
- D oxidise iodide ions to iodine.

- 6 Which molecule is non-polar?
- A  $\text{H}_2\text{S}$
  - B  $\text{NH}_3$
  - C  $\text{PF}_3$
  - D  $\text{SF}_6$
- 7 The element boron has a relative atomic mass of 10.8. In this sample, boron exists as two isotopes,  $^{10}\text{B}$  and  $^{11}\text{B}$ . The percentage abundance of  $^{10}\text{B}$  in this sample of boron is
- A 10.8%.
  - B 20.0%.
  - C 80.0%.
  - D 89.2%.

- 8 When burned in oxygen magnesium forms magnesium oxide.



What is the number of molecules of oxygen required for the complete oxidation of 1.2g of magnesium?

- A  $1.5 \times 10^{22}$
- B  $3.0 \times 10^{22}$
- C  $3.0 \times 10^{23}$
- D  $6.0 \times 10^{23}$
- 9 Which statement describes the trends in electronegativity values in the Periodic Table?
- A Decrease across a Period and increase down a Group
- B Decrease across a Period and decrease down a Group
- C Increase across a Period and increase down a Group
- D Increase across a Period and decrease down a Group

- 10** Which of the following would exactly neutralise  $10.0 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$   $\text{NaOH}(\text{aq})$ ?
- A  $2.50 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$   $\text{CH}_3\text{COOH}$
- B  $5.00 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$   $\text{HCl}$
- C  $5.00 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$   $\text{H}_2\text{SO}_4$
- D  $3.00 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$   $\text{H}_3\text{PO}_4$

## Section B

Answer **all five** questions in the spaces provided.

**11** Sulfate, hydrogensulfate and thiosulfate ions are formed when sulfuric and thiosulfuric acids ionise.

**(a) (i)** Write the equation for the complete ionisation of thiosulfuric acid. [2 marks]

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**(ii)** Write the formula for the hydrogensulfate ion. [1 mark]

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**(b) (i)** Write the formula for ammonium sulfate. [1 mark]

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**(ii)** Describe the bonding in ammonium sulfate. [2 marks]

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(c) Describe how you could use chemical tests on an aqueous solution of ammonium sulfate to prove that it contains ammonium ions and sulfate ions. [4 marks]

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**12** Some properties of the metals sodium and aluminium are shown in the table below.

metal	charge on metal ion	electronic structure of the atom	melting point /°C
sodium	1+	$1s^2 2s^2 2p^6 3s^1$	98
aluminium	3+	$1s^2 2s^2 2p^6 3s^2 3p^1$	660

**(a)** Describe, without using a diagram, the bonding in sodium metal. [2 marks]

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**(b)** Explain why aluminium has a higher melting point than sodium. [2 marks]

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**(c) (i)** Write the equation, including state symbols, for the first ionisation energy of sodium. [2 marks]

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(ii) The first six ionisation energies, in  $\text{kJ mol}^{-1}$ , of sodium are 496, 4563, 6913, 9544, 13352 and 16611. Explain which of these values can be used to identify sodium as belonging to Group I of the Periodic Table. [2 marks]

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(iii) The outer electron in the sodium atom is located in the 3s orbital.  
Explain what is meant by the term **orbital**.  
[2 marks]

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(d) Aluminium forms covalent bonds with chlorine.

(i) Explain what is meant by the term **covalent bond**.  
[2 marks]

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(ii) Write the equation for the reaction of aluminium with chlorine to form aluminium chloride,  $\text{AlCl}_3$ .  
[1 mark]

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(iii) State the octet rule and explain whether the atoms in aluminium chloride obey the rule. [3 marks]

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**(Questions continue overleaf)**

**13 (a)** Zinc reacts with chlorine to form the ionic compound zinc chloride. Draw a dot and cross diagram, using outer electrons only, to show how zinc chloride,  $\text{ZnCl}_2$ , is formed from zinc and chlorine atoms. [2 marks]

**(b)** Zinc is an essential trace element. People who have a zinc deficiency can take hydrated zinc sulfate,  $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$ , as a dietary supplement.

The value of  $x$  can be determined by heating hydrated zinc sulfate to constant mass.

A student heated 5.65 g of hydrated zinc sulfate and obtained 3.85 g of anhydrous zinc sulfate.

**(i)** Calculate the number of moles of anhydrous zinc sulfate obtained. [1 mark]

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**(ii)** Calculate the mass of water present in the hydrated zinc sulfate. [1 mark]

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**14** Nitrogen and phosphorus are Group V elements. They form the toxic hydrides ammonia and phosphine.

**(a)** Ammonia is formed by the reversible reaction of nitrogen with hydrogen.

Write the equation for this reaction. [2 marks]

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**(b)** Phosphine is formed by the reaction of phosphorus with aqueous sodium hydroxide.

**(i)** Balance the equation for the formation of phosphine.  
[1 mark]



**(ii)** Deduce the oxidation number of phosphorus in:

$\text{P}_4$  \_\_\_\_\_

$\text{NaH}_2\text{PO}_2$  \_\_\_\_\_

$\text{PH}_3$  \_\_\_\_\_

[3 marks]

(iii) Explain, using the oxidation numbers of phosphorus, why the reaction is described as disproportionation. [3 marks]

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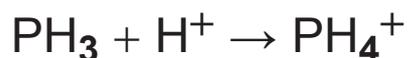
(c) The boiling point of ammonia is  $-33^{\circ}\text{C}$  while that of phosphine is  $-88^{\circ}\text{C}$ . Explain why the boiling point of ammonia is higher than that of phosphine. [3 marks]

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(d) Both ammonia and phosphine molecules react with  $\text{H}^+$  ions.



(i) Name the type of bond formed between a phosphine molecule and the  $\text{H}^+$  ion. [1 mark]

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(ii) Draw and name the shapes of the molecule  $\text{PH}_3$  and the ion  $\text{PH}_4^+$ . [4 marks]



Shape \_\_\_\_\_



Shape \_\_\_\_\_

(iii) Explain why the bond angle in  $\text{PH}_3$  is different from the bond angle in  $\text{PH}_4^+$ . [3 marks]

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(e) Ammonia is very soluble in water. Draw diagrams to show the two ways in which a molecule of ammonia can be attracted to a molecule of water. Include all partial charges and lone pairs in your diagram. [4 marks]

**15** Ammonia is used to make nitric acid by the Ostwald Process outlined below.



**(a) (i)** Calculate the number of moles of oxygen needed to react with 6.8 kg of ammonia. [3 marks]

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**(ii)** Calculate the number of moles of nitrogen(IV) oxide which can be obtained from 6.8 kg of ammonia. [2 marks]

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**(iii)** Calculate the concentration of nitric acid, in  $\text{g dm}^{-3}$ , produced on reacting the nitrogen(IV) oxide obtained in part **(ii)** with  $50 \text{ dm}^3$  of water. [3 marks]

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(b) Ammonia reacts with nitric acid according to the equation below.



The following results were obtained by diluting 25.0 cm<sup>3</sup> of a concentrated ammonia solution to 250.0 cm<sup>3</sup> in a volumetric flask and then titrating 25.0 cm<sup>3</sup> portions of the diluted ammonia solution using 0.100 mol dm<sup>-3</sup> nitric acid.

titration	initial burette reading/cm <sup>3</sup>	final burette reading/cm <sup>3</sup>	titre/cm <sup>3</sup>
rough	0.00	22.00	22.00
first accurate	0.10	21.40	21.30
second accurate	0.20	21.60	21.40

(i) Name a suitable indicator for the titration and state the colour change at the end point. [3 marks]

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(ii) Calculate the mean titre. [1 mark]

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(iii) A burette has an uncertainty of  $\pm 0.05 \text{ cm}^3$ . Calculate the uncertainty when two burette readings are used to calculate a titre value. [1 mark]

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(iv) Calculate the concentration of the concentrated ammonia solution in  $\text{mol dm}^{-3}$ . [5 marks]

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

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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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