



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

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]

TUESDAY 22 MAY, MORNING

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 fourteen** 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 four** questions in **Section B**.

You must answer the questions in the spaces provided.

Do not write on blank pages.

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(a)**.

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.

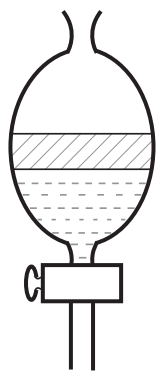
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(Questions start overleaf)

Section A

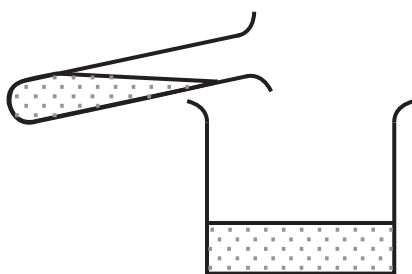
For each of the following questions only one of the lettered responses (A–D) is correct.

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

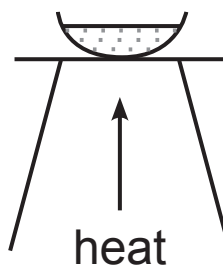
- 1 A solution of barium chloride was added to sodium sulfate solution.



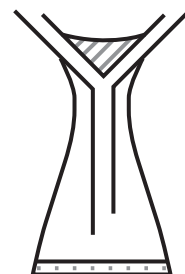
P



Q



R



S

Which combination of methods should be used to obtain the precipitate and the other product as a solid?

- A P + Q
- B P + R
- C Q + S
- D R + S

- 2 Which species has the same electronic arrangement as a lithium ion, Li^+ ?
- A Be^-
 - B B^{2+}
 - C H^+
 - D He

- 3 Sodium azide decomposes, in an airbag, to form sodium and nitrogen.



The sodium then reacts with potassium nitrate to form more nitrogen gas.

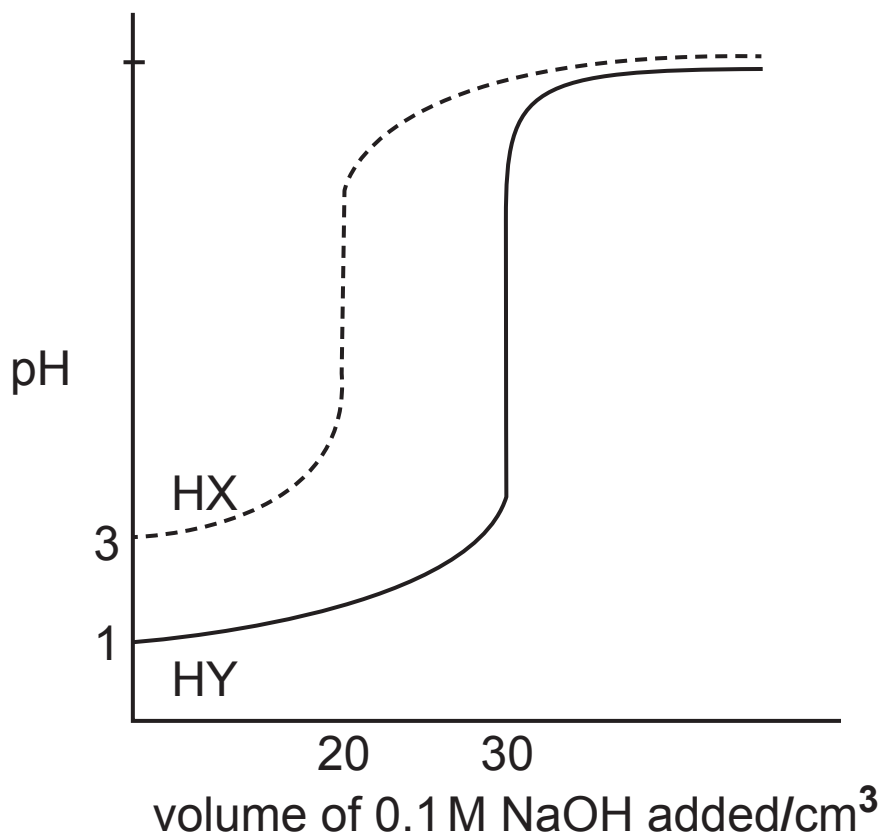


0.50 mol of sodium azide produces

- A 0.50 mol of nitrogen.
- B 0.75 mol of nitrogen.
- C 0.80 mol of nitrogen.
- D 2.00 mol of nitrogen.

- 4 Chlorine has two isotopes. How many peaks are there in the mass spectrum of chlorine?
- A 2
 - B 3
 - C 4
 - D 5
- 5 Which molecule is **not** planar?
- A BF_3
 - B BeCl_2
 - C HCHO
 - D NCl_3

- 6 The curves shown below are for 25 cm³ of acids HX and HY when they are reacted with 0.1 M sodium hydroxide solution.



Compared to acid HY, the acid HX is

- A more concentrated and stronger.
- B more concentrated and weaker.
- C less concentrated and stronger.
- D less concentrated and weaker.

- 7 The largest mass of silver chloride precipitated is when excess silver ions are added to
- A 25.0 cm³ of 0.80 M hydrochloric acid.
 - B 30.0 cm³ of 0.30 M iron(III) chloride solution.
 - C 50.0 cm³ of 0.20 M magnesium chloride solution.
 - D 50.0 cm³ of 0.50 M sodium chloride solution.
- 8 On melting, covalent bonds are broken in
- A bromine.
 - B diamond.
 - C sodium chloride.
 - D sulfur(IV) oxide.
- 9 Which of the following equations represents a redox reaction?
- A $\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2$
 - B $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$
 - C $2\text{CrO}_4^{2-} + 2\text{H}^+ \rightarrow \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O}$
 - D $\text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightarrow \text{NO}_2^+ + \text{H}_3\text{O}^+ + 2\text{HSO}_4^-$

10 Which halide has the most covalent character?

A AlBr_3

B AlF_3

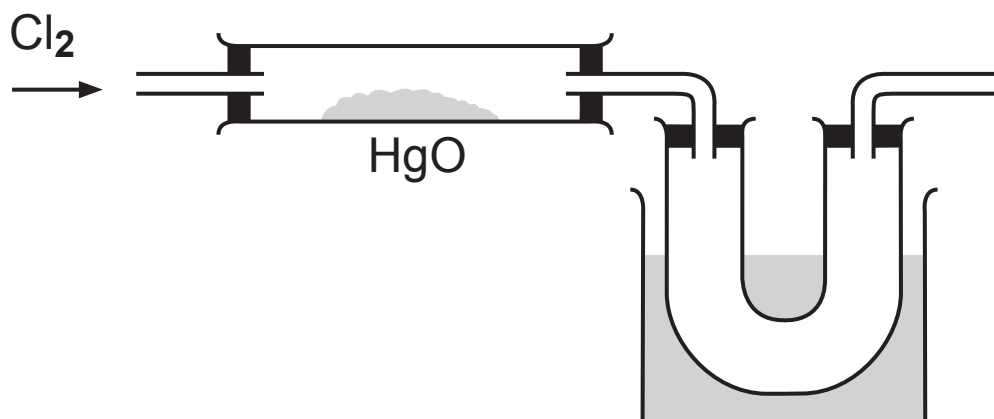
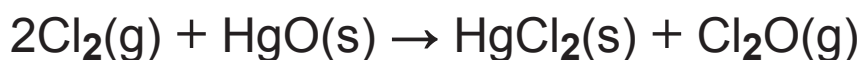
C MgBr_2

D MgF_2

Section B

Answer **all four** questions in this section

11 Chlorine monoxide is a brown-yellow gas with a boiling point of 4°C while chlorine has a boiling point of -34°C . The monoxide is formed when excess chlorine is passed over mercury(II) oxide.



The escaping gases are passed through a U-tube which is cooled to -30°C .

The chlorine monoxide condenses in the U-tube.

(a) (i) How could you test to show that chlorine is passing into the reaction tube? [2 marks]

(ii) What is the colour of chlorine? [1 mark]

(iii) Why is it important to limit the temperature of the U-tube to -30°C and not to have it lower than this temperature? [1 mark]

(iv) How could you show that it is a chloride which remains in the reaction tube? [3 marks]

(v) Mercury(II) oxide decomposes when heated to form oxygen and mercury. How could you show that there was no mercury(II) oxide left in the reaction tube at the end of the experiment? [3 marks]

(vi) Chlorine monoxide cannot be collected over water as it is very soluble in water, with a solubility of 143 g in 100 cm³ at room temperature and pressure. Explain how you could show that chlorine monoxide is very soluble in water. [4 marks]

(b) Chlorine monoxide slowly reacts with water to form hypochlorous acid



(i) Hypochlorous acid has a systematic name based on chloric acid. State the systematic name for hypochlorous acid. [1 mark]

(ii) Hypochlorous acid is a weak acid. Explain what is meant by the term **weak acid**. [2 marks]

(iii) Hypochlorous acid decomposes to give hydrochloric acid and oxygen.

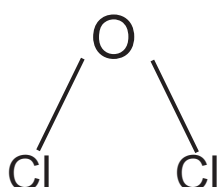
Write the equation for this reaction. [2 marks]

(c) Chlorine monoxide obeys the octet rule.

(i) State the **octet rule**. [2 marks]

(ii) Draw the electronic structure of chlorine monoxide showing the outer electrons only. [2 marks]

(d) Chlorine monoxide has the following shape.



(i) Name the shape. [1 mark]

(ii) How many lone pairs are there in a chlorine monoxide molecule? [1 mark]

(iii) Explain why chlorine monoxide forms this shape. [2 marks]

(e) Fluorine also forms an oxide but this oxide is known as oxygen fluoride because fluorine has a greater electronegativity than oxygen. State how electronegativity changes across a Period and down a Group. [2 marks]

(f) It has been suggested that chlorine monoxide is the active ingredient in the treatment of water for drinking purposes. Name **two** substances that are used to treat water for drinking. [2 marks]

12 Ammonium dichromate is used in the “volcano” experiment. When heated, it decomposes to produce a vast amount of green chromium oxide and gases which push out the green “ash” to form a pile of “lava”.



The water forms steam because of the heat of the reaction.

(a) Write the equation for the reaction, **with state symbols**, for the reactants and products. [1 mark]

(b) Ammonium dichromate is very soluble in water. At room temperature 10.0 g of ammonium dichromate dissolve in 25.0 cm³ of water. The orange solution can be tested for the presence of ammonium ions.

(i) Calculate the solubility of the ammonium dichromate in g dm⁻³ to 3 significant figures. [1 mark]

(ii) Calculate the solubility of the ammonium dichromate in mol dm⁻³ to 3 significant figures. [1 mark]

(iii) Explain how you would show that the orange solution contains ammonium ions. [3 marks]

(c) The nitrogen given off in the reaction consists of two isotopes, nitrogen-14 and nitrogen-15. The percentage abundance of nitrogen-14 is 99.632%.

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

(ii) Calculate the percentage abundance of nitrogen-15 given off. [1 mark]

(iii) Calculate the relative atomic mass of nitrogen to three decimal places. [2 marks]

(iv) Explain why there is a difference between the calculated relative atomic mass and the one provided in the data sheet. [1 mark]

(d) The dichromate ion is a very strong oxidising agent. The half-equation which shows its oxidising ability is:



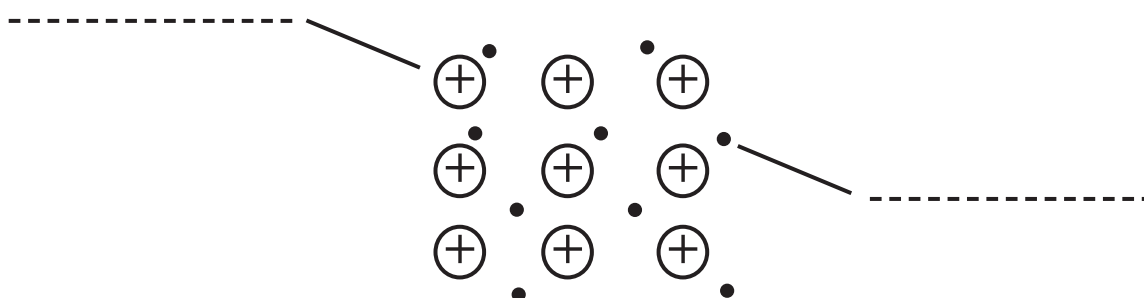
(i) Use this equation to explain, in terms of oxidation numbers, why the dichromate ion is an oxidising agent. [2 marks]

(ii) Use this equation to explain, in terms of electrons, why the dichromate ion is an oxidising agent. [1 mark]

(e) Dichromates react with chlorides in the presence of concentrated sulfuric acid to produce chromyl chloride, CrO_2Cl_2 , which is a deep red liquid with a boiling point of 117°C . Using this information, explain whether chromyl chloride is ionic or covalent. [2 marks]

(b) The different types of structure have different physical properties. State **four** physical properties that depend upon structure. [3 marks]

(c) The structure of sodium is shown below.

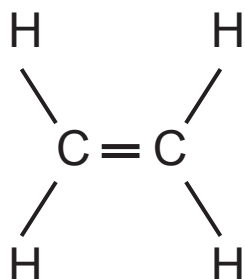


(i) Attach words to the labels shown. [2 marks]

(ii) Use this diagram to explain whether magnesium has a greater or lower conductivity than sodium. [2 marks]

(iii) Explain, using a labelled diagram, how you could compare the electrical conductivities of sodium and magnesium in the laboratory. [3 marks]

14 Ethene is a gas at room temperature and has a boiling point of -104°C at atmospheric pressure. It has a relative molecular mass of 28 which is approximately the same as the average relative molecular mass of air. It is a planar molecule which has the following structure:



(a) The ethene molecule contains single bonds and a double bond which are formed from s- and p-orbitals.

(i) Draw the shape of an s-orbital. [1 mark]

(ii) Draw the shape of a p-orbital. [1 mark]

(iii) Explain what is meant by the term **orbital**.
[2 marks]

(b) Ethene is a non-polar molecule. There are two reasons why ethene can be considered to be non-polar. One is based on electronegativity and the other is based on shape.

(i) What is meant by the term **electronegativity**?
[2 marks]

(ii) Explain why ethene is considered non-polar based on electronegativity. [1 mark]

(iii) Explain why ethene is considered non-polar based on shape. [1 mark]

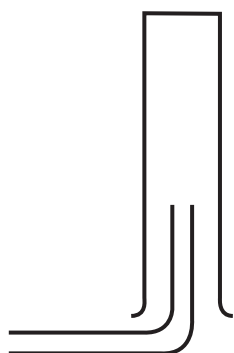
(c) Ethene contains a double bond. Other molecules can contain triple bonds.

(i) Draw the structure of the hydrocarbon ethyne which contains two carbon atoms and a triple bond. [1 mark]

(ii) Name an element which contains a triple bond. [1 mark]

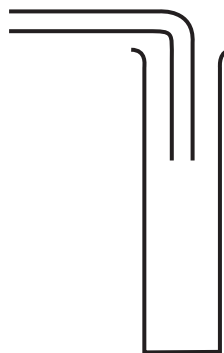
(d) When ethene burns, carbon dioxide and water are produced. Describe how you would carry out a test for carbon dioxide and the result expected for a positive test. [2 marks]

(e) Gases can be collected by two different methods A or B depending on their relative molecular masses compared to air.



gas lighter than air

A



gas heavier than air

B

(i) Explain which method could be used to collect methane, CH_4 . [1 mark]

(ii) Explain which method could be used to collect chlorine. [1 mark]

- (f) The boiling point of methane is $-161\text{ }^{\circ}\text{C}$. Explain why the boiling point of methane is lower than that of ethene. [2 marks]

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	
Total Marks	

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General Information

1 tonne = 10^6 g

1 metre = 10^9 nm

One mole of any gas at 293 K and a pressure of 1 atmosphere (10^5 Pa) occupies a volume of 24 dm^3

Avogadro Constant = $6.02 \times 10^{23} \text{ mol}^{-1}$

Planck Constant = $6.63 \times 10^{-34} \text{ Js}$

Specific Heat Capacity of water = $4.2 \text{ J g}^{-1} \text{ K}^{-1}$

Speed of Light = $3 \times 10^8 \text{ ms}^{-1}$

Characteristic absorptions in IR spectroscopy

Wavenumber/ cm^{-1}	Bond	Compound
550–850	C–X (X = Cl, Br, I)	Haloalkanes
750–1100	C–C	Alkanes, alkyl groups
1000–1300	C–O	Alcohols, esters, carboxylic acids
1450–1650	C=C	Arenes
1600–1700	C=C	Alkenes
1650–1800	C=O	Carboxylic acids, esters, aldehydes, ketones, amides, acyl chlorides
2200–2300	C≡N	Nitriles
2500–3200	O–H	Carboxylic acids
2750–2850	C–H	Aldehydes
2850–3000	C–H	Alkanes, alkyl groups, alkenes, arenes
3200–3600	O–H	Alcohols
3300–3500	N–H	Amines, amides

Proton Chemical Shifts in Nuclear Magnetic Resonance Spectroscopy (relative to TMS)

Chemical Shift	Structure	
0.5–2.0	–CH	Saturated alkanes
0.5–5.5	–OH	Alcohols
1.0–3.0	–NH	Amines
2.0–3.0	–CO–CH	Ketones
	–N–CH	Amines
	C_6H_5 –CH	Arene (aliphatic on ring)
2.0–4.0	X–CH	X = Cl or Br (3.0–4.0) X = I (2.0–3.0)
4.5–6.0	–C=CH	Alkenes
5.5–8.5	RCONH	Amides
6.0–8.0	– C_6H_5	Arenes (on ring)
9.0–10.0	–CHO	Aldehydes
10.0–12.0	–COOH	Carboxylic acids

These chemical shifts are concentration and temperature dependent and may be outside the ranges indicated above.

Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
Advanced Subsidiary and
Advanced Level Examinations

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations

gce a/as examinations chemistry

For first teaching from September 2016
For first award of AS Level in Summer 2017
For first award of A Level in Summer 2018
Subject Code: 1110

