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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 2  
assessing  
Module 2: Organic, Physical  
and Inorganic Chemistry

[AC122]

MV18

MONDAY 5 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 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.**

Complete in black ink only.

## Information for Candidates

The total mark for this paper is 100.

Quality of written communication will be assessed in  
**Question 14(f).**

In Section A all questions carry equal marks, i.e. **two** marks 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 the Elements, containing some data, is included in this question paper.

## 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 contains 52.0 g of barium chloride in 500 cm<sup>3</sup>. Which one of the following is the concentration of chloride ions?

A 0.125 mol dm<sup>-3</sup>

B 0.250 mol dm<sup>-3</sup>

C 0.500 mol dm<sup>-3</sup>

D 1.000 mol dm<sup>-3</sup>

2 A nucleophilic substitution reaction takes place when 1-bromopropane is heated with potassium cyanide in ethanol. Which one of the following is the organic product?

A Butanenitrile

B Butylamine

C Propanenitrile

D Propene

3 A student wanted to prepare 6.85 g of 1-bromobutane from butan-1-ol. Assuming a 40% yield, which one of the following is the minimum mass of butan-1-ol that the student would need to use?

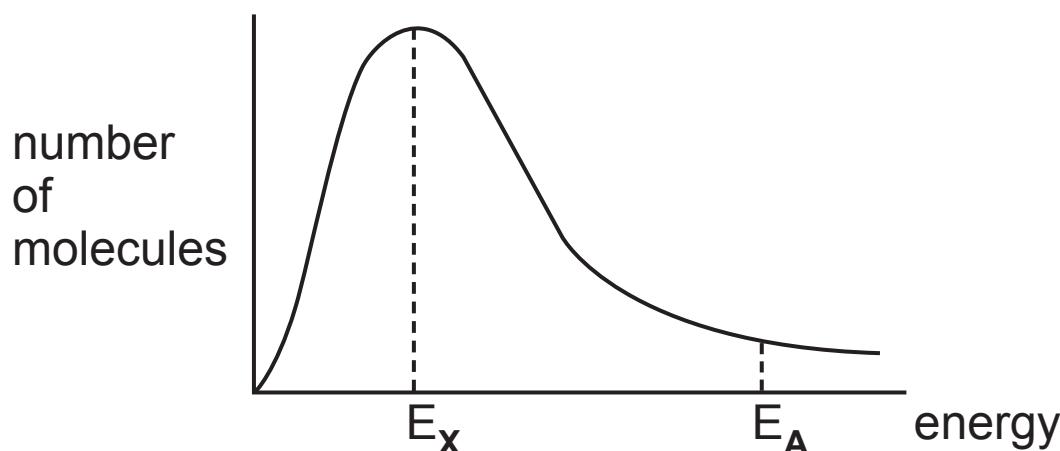
A 1.48 g

B 2.74 g

C 3.70 g

D 9.25 g

4 The diagram below shows the Maxwell–Boltzmann distribution of molecular energies in a gaseous reaction mixture.



Which one of the following shows the effect of an increase in temperature on the number of molecules with energies  $E_x$  and  $E_A$ ?

	<b>number of molecules with energy <math>E_x</math></b>	<b>number of molecules with energy <math>E_A</math></b>
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

5 An oil with the formula  $C_{57}H_{104}O_6$  was hardened to form an hydrogenated oil with the formula  $C_{57}H_{110}O_6$ . Which one of the following volumes of hydrogen gas, measured at 20 °C and one atmosphere pressure, is required to react with 8.84 g of the oil?

A  $240\text{ cm}^3$

B  $480\text{ cm}^3$

C  $720\text{ cm}^3$

D  $1440\text{ cm}^3$

6 The conversion of propan-2-ol to propanone can be monitored using infrared spectroscopy. Which one of the following confirms **complete** conversion?

A The absence of a C=O absorption

B The absence of an O–H absorption

C The presence of a C=O absorption

D The presence of an O–H absorption

7 Which one of the following is endothermic?

- A  $\text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2\text{H}_2\text{O}$
- B  $2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$
- C  $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$
- D  $\text{Sr} + 2\text{H}_2\text{O} \rightarrow \text{Sr}(\text{OH})_2 + \text{H}_2$

8 Which one of the following can **not** act as a nucleophile?

- A  $\text{H}^-$
- B  $\text{H}_2$
- C  $\text{H}_2\text{O}$
- D  $\text{CN}^-$

9 Which one of the following shows the equation for the standard enthalpy of formation of fluoromethane?

- A  $\text{C(g)} + 3\text{H(g)} + \text{F(g)} \rightarrow \text{CH}_3\text{F(g)}$
- B  $\text{C(s)} + 1\frac{1}{2}\text{H}_2\text{(g)} + \text{F(g)} \rightarrow \text{CH}_3\text{F(l)}$
- C  $\text{C(s)} + 1\frac{1}{2}\text{H}_2\text{(g)} + \frac{1}{2}\text{F}_2\text{(g)} \rightarrow \text{CH}_3\text{F(g)}$
- D  $\text{C(s)} + 1\frac{1}{2}\text{H}_2\text{(g)} + \frac{1}{2}\text{F}_2\text{(g)} \rightarrow \text{CH}_3\text{F(l)}$

**10** Ethanol is manufactured by the reaction

- A of steam with ethene in the presence of  $\text{H}_3\text{PO}_4$  below 373 K.
- B of steam with ethene in the presence of  $\text{H}_3\text{PO}_4$  above 373 K.
- C of water with ethene in the presence of  $\text{H}_2\text{SO}_4$  below 373 K.
- D of water with ethene in the presence of  $\text{H}_2\text{SO}_4$  above 373 K.

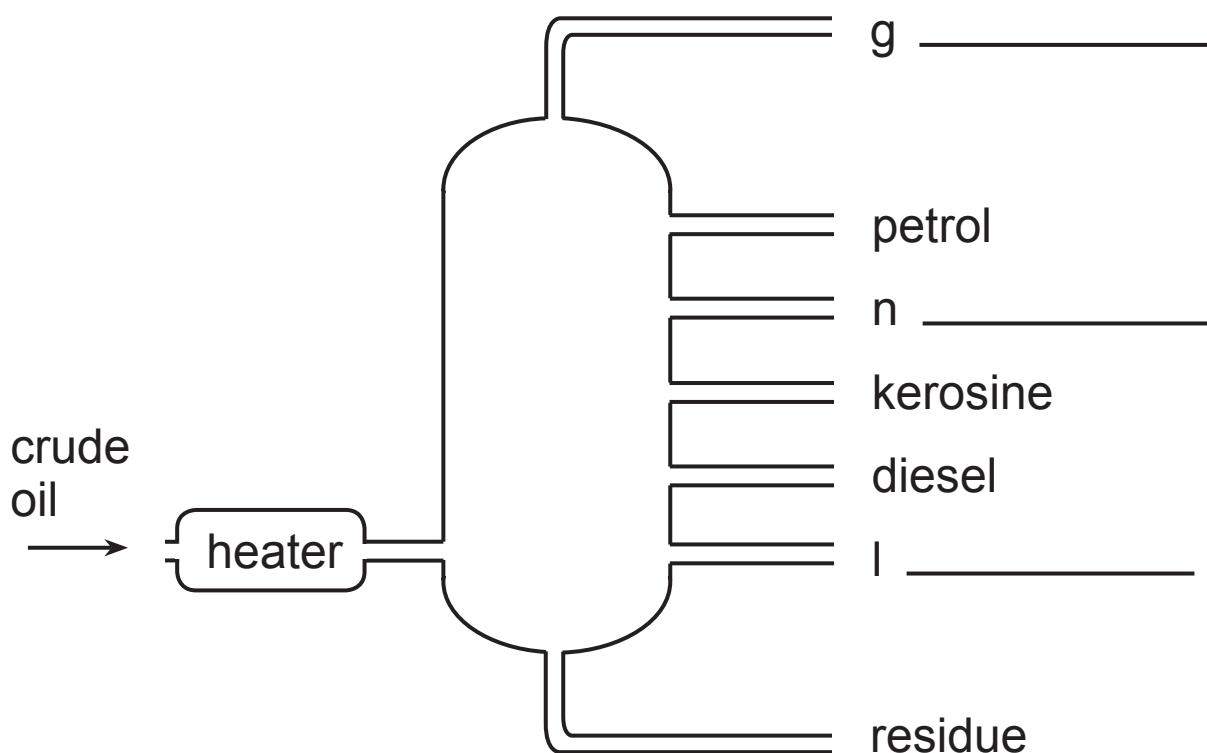
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**(Questions continue overleaf)**

## Section B

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

11 The diagram below represents the separation of organic chemicals in crude oil.



(a) (i) Complete the **three** labels on the diagram.  
[3 marks]

(ii) What property of these organic chemicals enables them to be separated? [1 mark]

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(b) Explain the meaning of the term **organic**. [1 mark]

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**(c)** What name is given to the process shown in the diagram? [2 marks]

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**(d)** Name the products when these organic chemicals are burnt in a plentiful supply of air. [2 marks]

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**(e)** Name the products when these organic chemicals are burnt in a limited supply of air. [2 marks]

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**12** The Group II elements have similar reactions and there are clear trends in the properties of the compounds.

**(a)** Magnesium and barium can be distinguished by their reaction with water and with dilute sulfuric acid.

**(i)** Give **three** observations when magnesium ribbon is added to an excess of dilute sulfuric acid.  
[3 marks]

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**(ii)** Write the equation for the reaction of magnesium with sulfuric acid. [1 mark]

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**(iii)** Explain why the reaction of barium with dilute sulfuric acid stops after a short time but it reacts completely and very quickly with water.  
[3 marks]

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**(b)** Draw a labelled diagram to show how 20 cm<sup>3</sup> of 1 mol dm<sup>-3</sup> sulfuric acid could be added to 0.24 g of magnesium to form and collect hydrogen gas. The gas is collected at room temperature and pressure (without any loss of gas) and its volume must be measured on collection. [4 marks]

**(c)** Explain why the carbonates of calcium, magnesium and barium dissolve very quickly in dilute nitric acid. [2 marks]

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(d) Barium carbonate decomposes at 1470 °C which is above the temperature attained by a Bunsen burner. The decomposition temperature of magnesium carbonate is 350 °C. Calcium carbonate is decomposed at 900 °C, the temperature of a Bunsen burner flame.

(i) If you had three white solids which were magnesium, calcium and barium carbonates how could you determine which was which without using a flame test? [3 marks]

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(ii) Explain the thermal stability of the Group II carbonates in terms of their cations. [3 marks]

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(e) Barium chloride solution can be used to detect aqueous sulfate and aqueous chromate ions.

(i) Describe the result for a positive test in each case.  
[2 marks]

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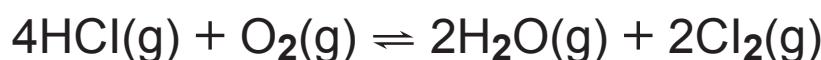
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(ii) Write the equations for the reactions. [2 marks]

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13 The Deacon process was a method of producing chlorine. Hydrogen chloride gas was mixed with air and passed over copper(II) chloride. The following equilibrium occurs.



The process was carried out at a temperature of 450 °C.

(a) (i) Suggest the purpose of the copper(II) chloride.  
[1 mark]

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(ii) Explain whether the process should be carried out at a low or high pressure to give the maximum yield.  
[2 marks]

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(iii) Explain what would happen to the equilibrium if oxygen was used rather than air. [1 mark]

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(iv) Suggest why air was used rather than oxygen in the original process. [1 mark]

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(v) The oxidation of hydrogen chloride is an exothermic reaction. Explain why the process is operated at the compromise temperature of 450 °C. [2 marks]

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(b) The enthalpy change for the reaction can be calculated using bond enthalpies. Use the values in the table below to calculate  $\Delta H$  for the reaction. [3 marks]

bond	bond enthalpy / kJ mol <sup>-1</sup>
H–Cl	432
O=O	498
Cl–Cl	243
O–H	464

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(c) The Deacon process was carried out in the laboratory. Tests were performed to confirm the identities of the four chemicals involved.

(i) Describe the chemical tests for the following chemicals.

Hydrogen chloride gas: [2 marks]

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Oxygen gas: [2 marks]

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Chlorine gas: [2 marks]

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(ii) Suggest how you could confirm the identity of  $\text{H}_2\text{O}(\text{g})$ . [2 marks]

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(d) A very similar process to the Deacon process is the oxychlorination of ethene to produce 1,2-dichloroethane. It uses copper(II) chloride and also recycles waste hydrogen chloride.



The 1,2-dichloroethane is thermally cracked to produce vinyl chloride,  $\text{CH}_2=\text{CHCl}$ , which may be used in the production of polyvinyl chloride.

(i) Draw the structure of 1,2-dichloroethane showing all the bonds present. [2 marks]

(ii) Explain what is meant by the term **thermal cracking**. [2 marks]

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**(iii) Draw the structure of polyvinyl chloride, showing three repeating units. [3 marks]**

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**(Questions continue overleaf)**

14 If a molecule has a double bond and an –OH group it is called an alkenol. Octenol is an alkenol which is found in human breath and sweat. It has the name “mushroom alcohol” and smells “green and mouldy” or meaty. Mosquitoes are attracted to it and it is manufactured under the name Lurex.



octenol (Lurex)

(a) Suggest the systematic name for octenol. [2 marks]

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(b) Write the general formulae for alkenes and alcohols and suggest a general formula for an alkenol. [2 marks]

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(c) Explain whether octenol has E and Z isomers.

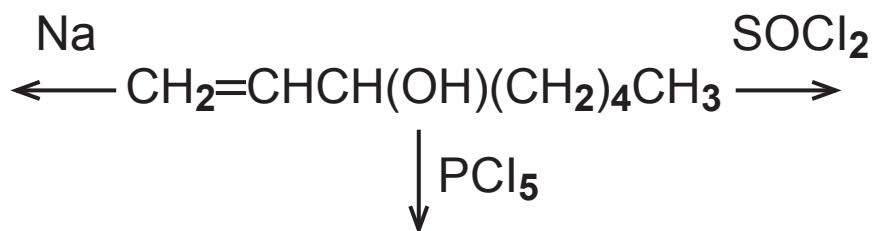
[2 marks]

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(d) Octenol contains a secondary alcohol group which reacts in the same way as a primary alcohol group with thionyl chloride, sodium, hydrogen bromide and phosphorus pentachloride.

(i) Complete the reaction sequence below. [3 marks]



(ii) Octenol reacts with hydrogen bromide to give five possible products with different structures. Draw the structures of the five products. [3 marks]

(e) The –OH group in octenol is oxidised to produce a ketone known as octenone which is the chemical responsible for the typical “metallic smell” of metals when they are handled.

(i) Name the oxidising agent used to oxidise octenol.  
[1 mark]

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(ii) Using [O] to represent the oxidising agent, write the equation for the oxidation. [2 marks]

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(iii) State how you would isolate octenone from the reaction mixture. [1 mark]

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**(f)** Explain how you would use a chemical test to show the presence of the C=C double bond in octenol.  
[3 marks]

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Quality of written communication [2 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	
Total Marks	

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## Periodic Table of the Elements

For the use of candidates taking  
Advanced Subsidiary and Advanced Level  
Chemistry 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  
(advanced)



I	II	THE PERIODIC TABLE OF ELEMENTS												III	IV	V	VI	VII	O
1 <b>H</b> Hydrogen		One mole of any gas at 20°C and a pressure of 1 atmosphere (10 <sup>5</sup> Pa) occupies a volume of 24 dm <sup>3</sup> . Planck Constant = 6.63 × 10 <sup>-34</sup> Js Gas Constant = 8.31 J mol <sup>-1</sup> K <sup>-1</sup> Avogadro Constant = 6.02 × 10 <sup>23</sup> mol <sup>-1</sup>												4 <b>He</b> Helium					
7 <b>Li</b> Lithium	9 <b>Be</b> Beryllium													2 <b>He</b> Neon					
23 <b>Na</b> Sodium	24 <b>Mg</b> Magnesium													20 <b>Ne</b> Argon					
39 <b>K</b> Potassium	40 <b>Ca</b> Calcium	45 <b>Sc</b> Scandium	48 <b>Ti</b> Titanium	51 <b>V</b> Vanadium	52 <b>Cr</b> Chromium	55 <b>Mn</b> Manganese	56 <b>Fe</b> Iron	59 <b>Co</b> Cobalt	59 <b>Ni</b> Nickel	64 <b>Cu</b> Copper	65 <b>Zn</b> Zinc	70 <b>Ga</b> Gallium	73 <b>Ge</b> Germanium	75 <b>As</b> Arsenic	79 <b>Se</b> Selenium	80 <b>Br</b> Bromine	84 <b>Kr</b> Krypton		
19 <b>Rb</b> Rubidium	38 <b>Sr</b> Strontium	39 <b>Y</b> Yttrium	40 <b>Zr</b> Zirconium	41 <b>Nb</b> Niobium	42 <b>Mo</b> Molybdenum	43 <b>Tc</b> Technetium	44 <b>Ru</b> Ruthenium	45 <b>Rh</b> Rhodium	46 <b>Pd</b> Palladium	47 <b>Ag</b> Silver	48 <b>Cd</b> Cadmium	49 <b>In</b> Indium	50 <b>Sn</b> Tin	51 <b>Sb</b> Antimony	52 <b>Te</b> Tellurium	53 <b>I</b> Iodine	54 <b>Xe</b> Xenon		
133 <b>Cs</b> Caesium	137 <b>Ba</b> Barium	139 <b>La</b> <sup>*</sup> Lanthanum	178 <b>Hf</b> Hafnium	181 <b>Ta</b> Tantalum	184 <b>W</b> Tungsten	186 <b>Re</b> Rhenium	190 <b>Os</b> Osmium	192 <b>Ir</b> Iridium	195 <b>Pt</b> Platinum	197 <b>Au</b> Gold	201 <b>Hg</b> Mercury	204 <b>Tl</b> Thallium	207 <b>Pb</b> Lead	209 <b>Bi</b> Bismuth	210 <b>Po</b> Polonium	210 <b>At</b> Astatine	222 <b>Rn</b> Radon		
223 <b>Fr</b> Francium	226 <b>Ra</b> Radium	227 <b>Ac</b> <sup>†</sup> Actinium																	

\* 58–71 Lanthanum series  
† 90–103 Actinium series

**a** = relative atomic mass (approx.)  
**x** = atomic symbol  
**b** = atomic number

140 <b>Ce</b> Cerium	141 <b>Pr</b> Praseodymium	144 <b>Nd</b> Neodymium	147 <b>Pm</b> Promethium	150 <b>Sm</b> Samarium	152 <b>Eu</b> Europium	157 <b>Gd</b> Gadolinium	159 <b>Tb</b> Terbium	162 <b>Dy</b> Dysprosium	165 <b>Ho</b> Holmium	167 <b>Er</b> Erbium	169 <b>Tm</b> Thulium	173 <b>Yb</b> Ytterbium	175 <b>Lu</b> Lutetium
58 <b>Th</b> Thorium	59 <b>Pa</b> Protactinium	60 <b>U</b> Uranium	61 <b>Np</b> Neptunium	62 <b>Pu</b> Plutonium	63 <b>Am</b> Americium	64 <b>Cm</b> Curium	65 <b>Bk</b> Berkelium	66 <b>Cf</b> Californium	67 <b>Es</b> Einsteinium	68 <b>Fm</b> Fermium	69 <b>Md</b> Mendelevium	70 <b>No</b> Nobelium	71 <b>Lr</b> Lawrencium