Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Centre Number

Candidate Number

Chemistry

Assessment Unit AS 2
assessing
Module 2: Organic, Physical and Inorganic Chemistry

MV18

[AC122]

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^3. Which one of the following is the concentration of chloride ions?

A 0.125 mol dm^{-3}

B 0.250 mol dm^{-3}

C 0.500 mol dm^{-3}

D 1.000 mol dm^{-3}

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?

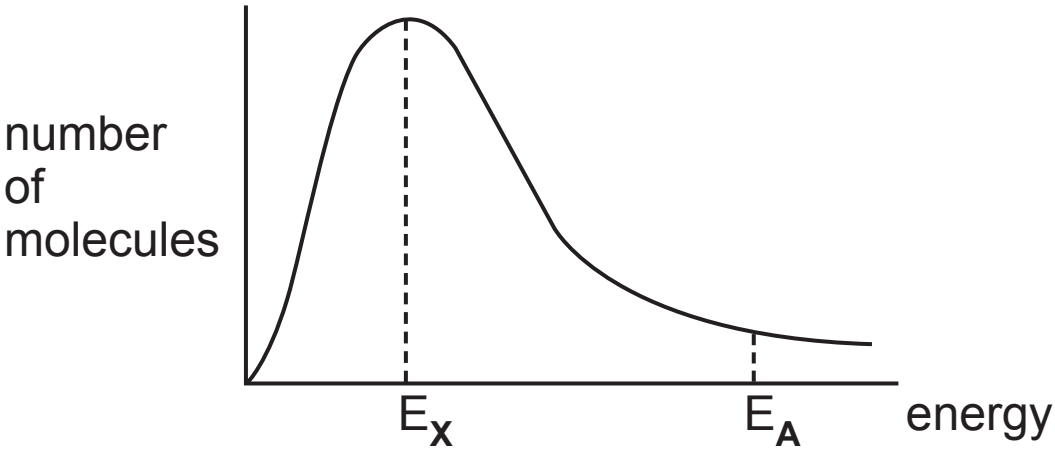
A 1.48 g

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?

	number of molecules with energy E_X	**number of molecules with energy E_A**
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 cm^3

B 480 cm^3

C 720 cm^3

D 1440 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 $H_3O^+ + OH^- \rightarrow 2H_2O$

B $2NH_3 \rightarrow N_2 + 3H_2$

C $2SO_2 + O_2 \rightarrow 2SO_3$

D $Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$

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

A H^-

B H_2

C H_2O

D CN^-

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

A $C(g) + 3H(g) + F(g) \rightarrow CH_3F(g)$

B $C(s) + 1\frac{1}{2}H_2(g) + F(g) \rightarrow CH_3F(l)$

C $C(s) + 1\frac{1}{2}H_2(g) + \frac{1}{2}F_2(g) \rightarrow CH_3F(g)$

D $C(s) + 1\frac{1}{2}H_2(g) + \frac{1}{2}F_2(g) \rightarrow CH_3F(l)$

10 Ethanol is manufactured by the reaction

A of steam with ethene in the presence of H_3PO_4 below 373 K.

B of steam with ethene in the presence of H_3PO_4 above 373 K.

C of water with ethene in the presence of H_2SO_4 below 373 K.

D of water with ethene in the presence of H_2SO_4 above 373 K.

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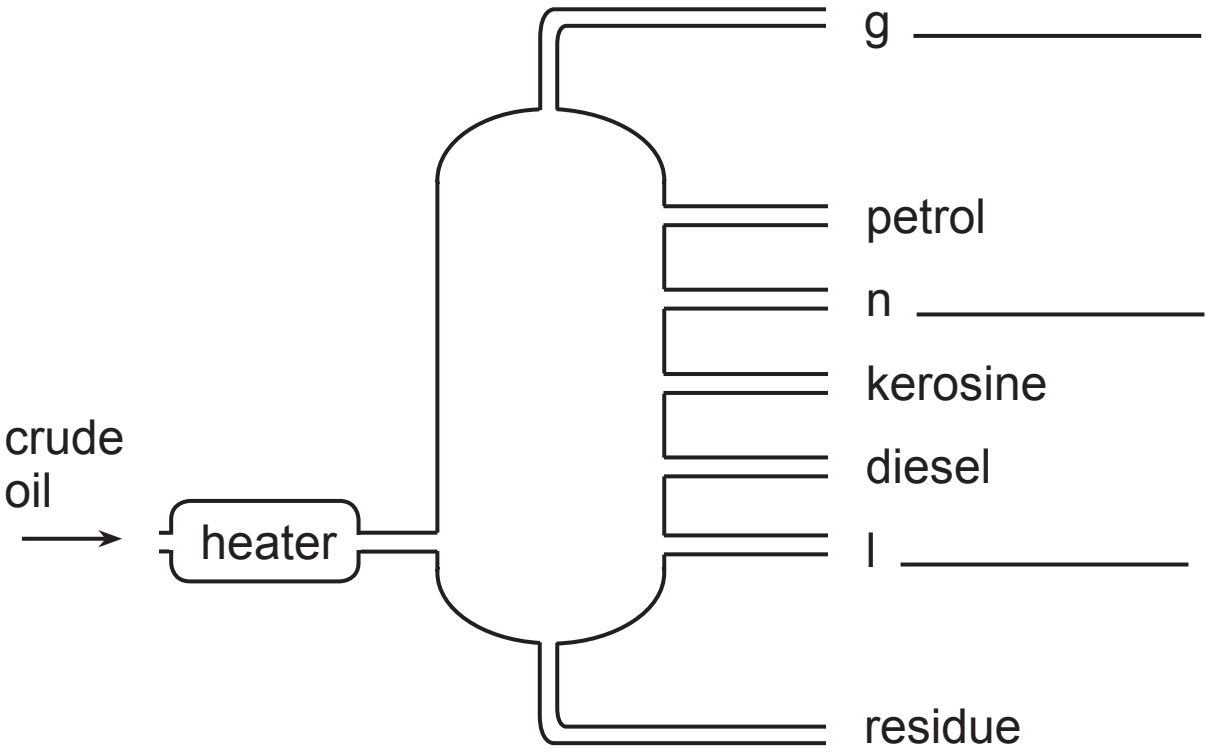
(Questions continue overleaf)

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]

_____

_____

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

_____

_____

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

_____

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

_____

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

_____

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]

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

(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]

(b) Draw a labelled diagram to show how 20 cm^3 of 1 mol dm^{-3} 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]

(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]

_____

_____

_____

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

_____

_____

_____

(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]

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

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.

$$4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g)$$

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

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

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

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

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

(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]

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

bond	**bond enthalpy / kJ mol^{-1}**
H–Cl	432
O=O	498
Cl–Cl	243
O–H	464

(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]

Oxygen gas: [2 marks]

Chlorine gas: [2 marks]

(ii) Suggest how you could confirm the identity of $H_2O(g)$. [2 marks]

(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.

$$2HCl(g) + \tfrac{1}{2}O_2(g) + C_2H_4(g) \rightleftharpoons C_2H_4Cl_2(g) + H_2O(g)$$

The 1,2-dichloroethane is thermally cracked to produce vinyl chloride, $CH_2{=}CHCl$, 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]

(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.

$CH_2{=}CHCH(OH)CH_2CH_2CH_2CH_2CH_3$

octenol (Lurex)

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

_____

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

_____

_____

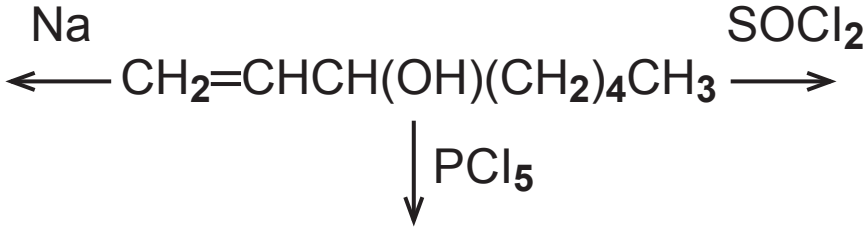
(c) Explain whether octenol has E and Z isomers. [2 marks]

_____

_____

(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]

_____

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

_____

_____

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

_____

_____

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

Quality of written communication [2 marks]

THIS IS THE END OF THE QUESTION PAPER

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)

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THE PERIODIC TABLE OF ELEMENTS

I	II										III	IV	V	VI	VII	0
1 H Hydrogen 1																4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La* Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac† Actinium 89														

One mole of any gas at 20 °C and a pressure of 1 atmosphere (10^5 Pa) occupies a volume of 24 dm^3.

Planck Constant = 6.63×10^{-34} Js

Gas Constant = 8.31 J mol^{-1} K^{-1}

Avogadro Constant = 6.02×10^{23} mol^{-1}

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	242 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	245 Bk Berkelium 97	251 Cf Californium 98	254 Es Einsteinium 99	253 Fm Fermium 100	256 Md Mendelevium 101	254 No Nobelium 102	257 Lr Lawrencium 103

* 58–71 Lanthanum series

† 90–103 Actinium series

a / b x

a = relative atomic mass (approx.)

x = atomic symbol

b = atomic number