



Rewarding Learning

ADVANCED
General Certificate of Education
2019

Centre Number

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Candidate Number

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Chemistry

Assessment Unit A2 3

assessing

Further Practical Chemistry

Practical Booklet B (Theory)



[ACH32]

ACH32

WEDNESDAY 19 JUNE, MORNING

TIME

1 hour 15 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

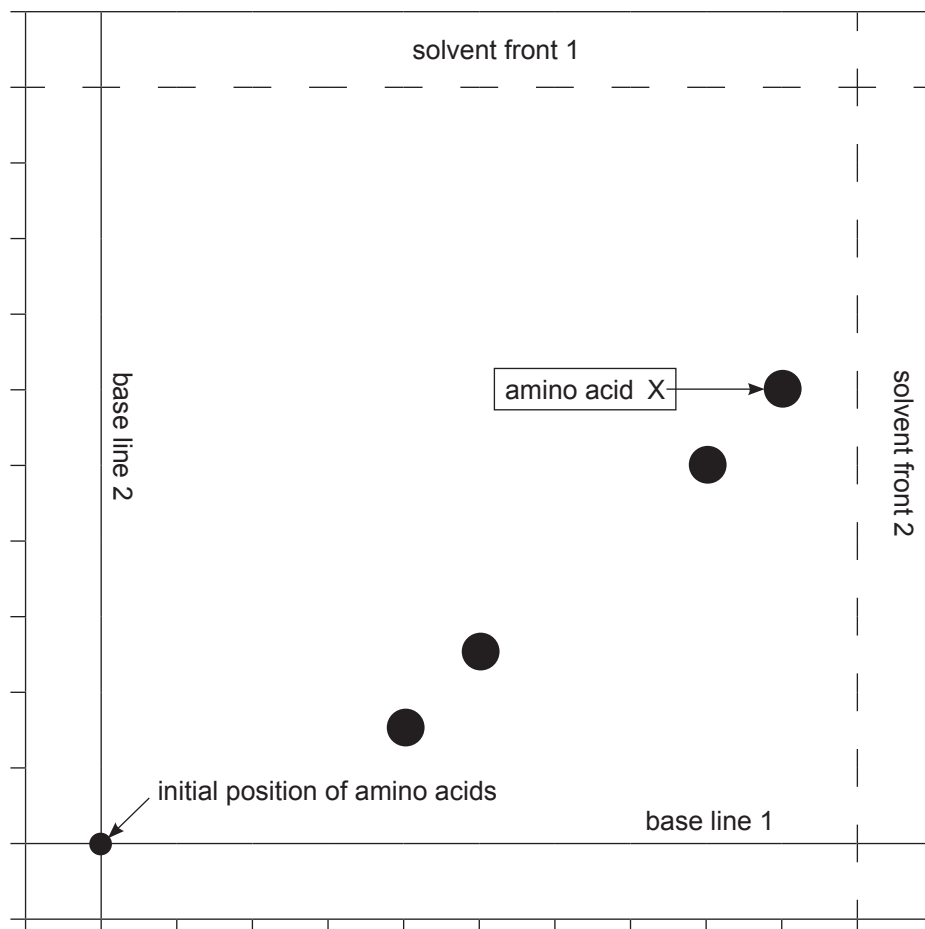
A Periodic Table of Elements (including some data) is provided.

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16ACH3201

- 1 A mixture of amino acids was analysed using two-way paper chromatography. The first “solvent” used was a solution of butan-1-ol in ethanoic acid. The second “solvent” was a solution of phenol in water. The chromatogram obtained is shown below.



- (a) A spot of the mixture was placed on base line 1 using a capillary tube. Describe, giving experimental details, how this chromatogram would be obtained.

[4]



(b) Calculate the R_f values for the amino acid, X, in solvents 1 and 2. Measure to the middle of the spot.

Solvent 1 _____

Solvent 2 _____ [1]

(c) Without access to R_f data, how would you show that the amino acid leucine was present and the amino acid serine was absent from the mixture?

_____ [2]

(d) Why is two-way paper chromatography a better method for separating amino acids than one-way paper chromatography?

_____ [1]

(e) GLC MS can be used to identify drugs and determine their purity.

(i) How would GLC indicate that a drug was pure?

_____ [1]

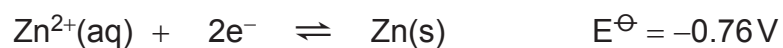
(ii) Give **two** ways in which the identity of a drug can be established using GLC MS.

_____ [2]

[Turn over



2 The standard electrode potentials of two half-cells are given below.



(a) Define the term **standard electrode potential**.

[2]

(b) (i) Draw a labelled diagram to show the cell which you would use to measure the potential difference between these two half-cells under standard conditions. Your diagram should include the concentrations of any ions in solution and the temperature at which the measurement would be made.

[4]



(ii) Calculate the emf of this cell.

[1]

(c) Magnesium is a stronger reducing agent than zinc. The standard electrode potential of the magnesium half-cell can be determined by setting up the following cell:



This cell has an emf of +1.61 V. Calculate the standard electrode potential of the magnesium half-cell.

[1]



3 A series of tests was carried out on two organic liquids, **A** and **B**.

(a) Liquid **A** produced an orange solid when reacted with 2,4-dinitrophenylhydrazine and a silver mirror when heated with Tollens' reagent. The mass spectrum of **A** showed a molecular ion peak at 58.

(i) To which homologous series does **A** belong? Explain how the results of the chemical tests are consistent with your conclusion.

[3]

(ii) Name **A** and identify the molecular ion.

[1]

(b) Liquid **B** reacted vigorously with phosphorus pentachloride, and an aqueous solution of **B** gave effervescence on addition of sodium carbonate. The high resolution nmr spectrum of **B** contains a singlet, a quartet and a triplet.

(i) To which homologous series does **B** belong? Explain how the results of the chemical tests are consistent with your conclusion.

[3]



- (ii) Give the structure of **B** and circle the hydrogen(s) responsible for the singlet. Suggest a chemical shift value for the position of the singlet.

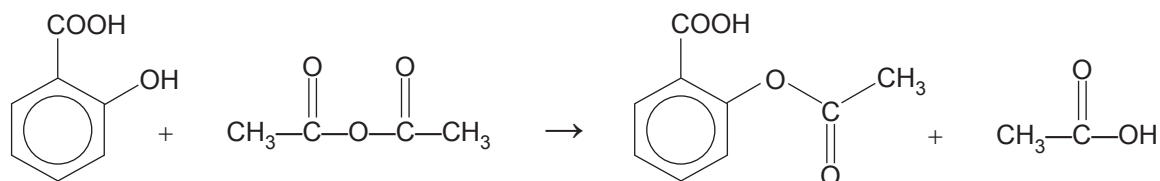
_____ [2]

- (iii) Explain how the spin-spin splitting in the nmr spectrum is consistent with the structure given in (ii).

_____ [2]



- 4 In the presence of concentrated phosphoric acid, salicylic acid reacts with ethanoic anhydride to form aspirin and ethanoic acid.



Addition of cold water causes the crude product to precipitate as a white solid which is filtered off and recrystallised. The purity of the final product is confirmed by carrying out a melting point determination.

- (a) Assuming a 40% yield, calculate the minimum mass of salicylic acid required to form 18.0g of aspirin.

[3]



(b) Describe the purification of aspirin by recrystallisation.

[4]

(c) Describe the melting point determination and explain how the result can be used to confirm the purity of the product.

[5]

(d) Volumetric analysis of a solution containing aspirin can be carried out by adding an excess of sodium hydroxide solution, warming the mixture to hydrolyse the ester group and then titrating the excess sodium hydroxide with a standard solution of hydrochloric acid.

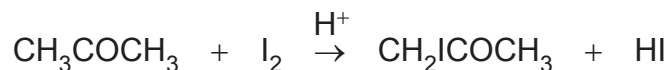
Write an equation for the reaction of aspirin with excess sodium hydroxide.

[1]

[Turn over



- 5 Iodine reacts with propanone, in the presence of an acid catalyst, according to the following equation:



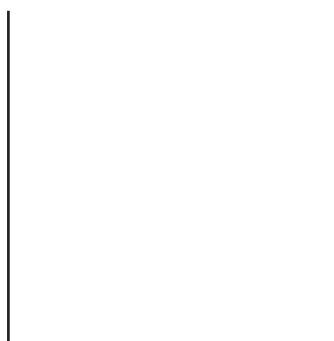
The order of reaction with respect to iodine can be determined by mixing iodine with a large excess of both propanone and hydrochloric acid, starting a stopclock and then monitoring how the concentration of iodine changes with respect to time.

- (a) How could you determine the concentration of iodine at regular time intervals using colorimetry?

[4]

- (b) A graph of iodine concentration against time can be used to show that the reaction is zero order with respect to iodine.

- (i) Sketch the graph and label the axes.



[2]



(ii) How can the graph be used to determine the rate of the reaction?

[1]

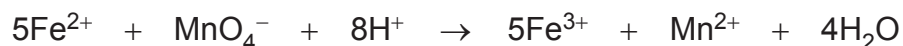
(c) Suggest why a large excess of propanone and hydrochloric acid is used.

[1]



6 A solution containing iron(II) ions was left exposed to the air for several days. Some of the iron(II) ions were oxidised to iron(III) ions.

(a) The number of moles of iron(II) ions present in the solution can be determined by titrating with acidified manganate(VII) solution.



(i) Why is no indicator required in this titration?

_____ [1]

(ii) Give the colour change at the end point.

_____ [2]

(b) A 25.0 cm^3 aliquot of the solution, which had been partially oxidised, was transferred into a conical flask. The solution was acidified and then titrated with $0.020 \text{ mol dm}^{-3}$ potassium manganate(VII). 18.0 cm^3 was required. Calculate the number of moles of iron(II) ions present in this aliquot.

_____ [2]



(c) Another portion of the solution, which had been partially oxidised, was treated with an excess of zinc. The unreacted zinc was then removed by filtration and 25.0 cm³ of the filtrate was transferred into a conical flask. The solution was acidified and then titrated with 0.020 mol dm⁻³ potassium manganate(VII) of which 30.0 cm³ was required.

(i) Use an equation to explain the purpose of the zinc.

[2]

(ii) Calculate the percentage of the iron(II) ions which had been oxidised in this solution.

[2]

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Question Number	Examiner Mark	Remark
1		
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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
	$\text{C}_6\text{H}_5\text{–CH}$	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

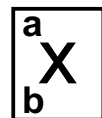
For first teaching from September 2016
For first award of AS Level in Summer 2017
For first award of A Level in Summer 2018
Subject Code: 1110

THE PERIODIC TABLE OF ELEMENTS
Group

I II III IV V VI VII 0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

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	98 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	261 Rf Rutherfordium 104	262 Db Dubnium 105	266 Sg Seaborgium 106	264 Bh Bohrium 107	277 Hs Hassium 108	268 Mt Meitnerium 109	271 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112								

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



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

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	145 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