Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

Centre Number

Candidate Number

Chemistry

Assessment Unit AS 3
assessing
Module 3: Basic
Practical Chemistry

MV18

Practical Booklet B (Theory)

[SCH32]

FRIDAY 1 JUNE, AFTERNOON

Time

1 hour 15 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.
You must answer the questions in the spaces provided.
Do not write on blank pages.
Complete in black ink only.
Answer **all four** questions.

Information for Candidates

The total mark for this paper is 55.
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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1 Oxalic acid is a white crystalline solid that occurs naturally in rhubarb. It is a dicarboxylic acid used in rust removal. It often contains water of crystallisation, $H_2C_2O_4.xH_2O$, the amount of which can be determined by titration with sodium hydroxide solution.

(a) Oxalic acid reacts with sodium hydroxide in a similar way to ethanoic acid. Write an equation for the reaction between oxalic acid and excess sodium hydroxide. [2 marks]

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(b) A 1.55 g sample of hydrated oxalic acid was dissolved in 50 cm^3 of deionised water in a beaker, transferred to a volumetric flask and the solution made up to 250.0 cm^3 with deionised water. The flask was stoppered and inverted.

(i) Explain how the loss of solution is minimised when it is transferred to the volumetric flask. [2 marks]

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(ii) Explain the purpose of inverting the volumetric flask. [1 mark]

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(c) 25.0 cm^3 of the oxalic acid solution were titrated against 0.10 mol dm^{-3} sodium hydroxide solution using phenolphthalein as an indicator. The titre was 24.6 cm^3.

(i) A burette reading is accurate to ± 0.05 cm^3. Calculate the percentage uncertainty in the titre value, to one significant figure. [2 marks]

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(ii) State the colour change at the end point of the titration. [2 marks]

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(iii) Use the titre value and the mass of the sample to calculate the relative formula mass of hydrated oxalic acid. [3 marks]

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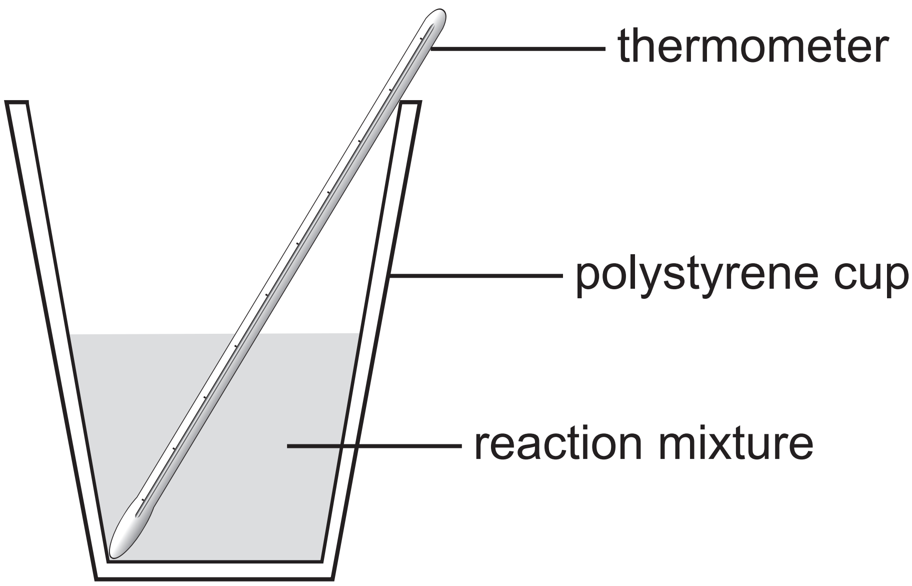
(iv) Use your answer to part **(iii)** to calculate the value of x in the hydrated acid, $H_2C_2O_4.xH_2O$. [2 marks]

2 Hydrochloric acid reacts with sodium hydroxide solution in a neutralisation reaction.

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

The apparatus in the diagram below can be used to determine the enthalpy change for the reaction:



(a) (i) Heat loss to the surroundings is the main source of error in this experiment. Suggest **two** improvements to the apparatus in the diagram opposite that would minimise heat loss to the surroundings. [2 marks]

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(ii) Define the term **standard enthalpy of neutralisation**. [2 marks]

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(iii) State the conditions used for standard enthalpy changes. [2 marks]

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(b) The following procedure was followed in order to determine the enthalpy change for the reaction:

- Weigh 11 g of the corrosive solid sodium hydroxide and dissolve in 250 cm^3 of deionised water and allow to cool.
- Using a measuring cylinder, transfer 25 cm^3 of the sodium hydroxide solution into a polystyrene cup.
- Place a thermometer in the polystyrene cup and record the temperature of the sodium hydroxide solution.
- Place a thermometer in 25 cm^3 of 1.0 mol dm^{-3} hydrochloric acid and record the temperature of the acid. Transfer this solution to the polystyrene cup.
- Stir the reaction mixture with the thermometer and record the highest temperature obtained.

(i) Suggest a more accurate way of measuring the volume of the sodium hydroxide solution. [1 mark]

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(ii) Suggest and explain **two** safety precautions when using solid sodium hydroxide. [2 marks]

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(iii) Calculate the number of moles of sodium hydroxide in 25 cm^3 of solution, to two significant figures. [2 marks]

(iv) Calculate the number of moles of hydrochloric acid in 25 cm^3 of solution, to two significant figures. [1 mark]

(c) When the procedure was followed, a temperature rise of 6.2 °C was recorded.

(i) It is assumed that the specific heat capacity of the reaction mixture is 4.2 J g^{-1} K^{-1}. State **one** other assumption made about the reaction mixture when calculating the enthalpy change. [1 mark]

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(ii) Calculate the heat energy given out in kJ, to two significant figures. [2 marks]

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(iii) Calculate the molar enthalpy of neutralisation for the reaction in kJ mol^{-1}, to two significant figures. [2 marks]

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(d) The experiment was repeated using barium hydroxide in place of sodium hydroxide.

(i) Suggest why the molar enthalpy of neutralisation, obtained for this experiment, is similar to that calculated with sodium hydroxide. [1 mark]

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(ii) When the experiment is repeated with magnesium hydroxide in place of barium hydroxide, it is added as a solid to the hydrochloric acid in the polystyrene cup. Suggest why a solution of magnesium hydroxide is not used. [1 mark]

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(iii) Aqueous barium chloride is used to test for a specific ion. Name the ion and describe how the test is performed for this ion. Include the observation for a positive test. [3 marks]

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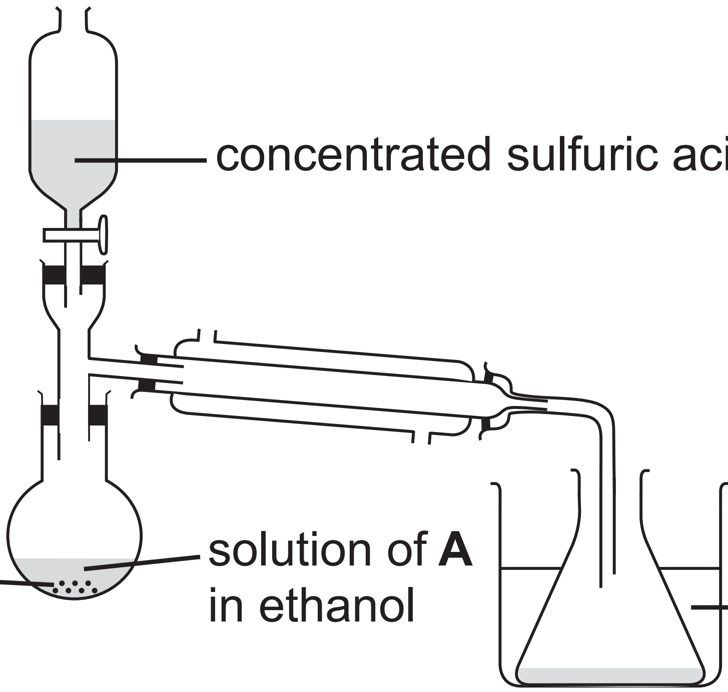
3 The oxidation of ethanol (density 0.79 g cm^{-3}, boiling point 78 °C) must be carefully controlled in order to produce ethanal (density 0.82 g cm^{-3}, boiling point 21 °C).

$$CH_3CH_2OH + [O] \rightarrow CH_3CHO + H_2O$$

Ethanal may be prepared using distillation apparatus, as shown in the diagram below.



The acid from the dropping funnel is added slowly. As the reaction proceeds and the solution in the round-bottom flask boils, a colourless liquid is collected in the conical flask.

(a) Identify **A** and **B**. [2 marks]

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(b) Suggest why a heat source is not required. [1 mark]

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(c) State the colour change observed in the round-bottom flask after the reaction is complete. [1 mark]

(d) Suggest why the conical flask is placed in an ice/water bath. [1 mark]

(e) Calculate the volume of ethanal, to two significant figures, that would be produced from 5.0 cm^3 of ethanol, assuming a yield of 45%. [5 marks]

(f) Suggest **one** practical and **one** theoretical reason why the yield is less than 100%. [2 marks]

4 In order to determine the relative atomic mass of a Group II metal, a known mass of the Group II carbonate, MCO_3, is added to excess hydrochloric acid in a conical flask. The carbon dioxide produced is collected in a gas syringe.

$$MCO_3 + 2HCl \rightarrow MCl_2 + H_2O + CO_2$$

(a) (i) State **one** observation which could be made that indicates the reaction is finished. [1 mark]

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(ii) State a test which could be made that indicates the hydrochloric acid is in excess. [2 marks]

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(b) Identify **one** source of error with the method that could lead to inaccuracy in the volume of carbon dioxide measured. [1 mark]

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(c) An alternative method involves collecting the carbon dioxide over water in a measuring cylinder.

(i) Suggest **one** reason why this method is less accurate than collecting the carbon dioxide in a gas syringe. [1 mark]

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(ii) Explain **one** way of improving the accuracy of measuring the volume of gas collected. [2 marks]

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THIS IS THE END OF THE QUESTION PAPER

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	

Total Marks	

Examiner Number

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 = 6.02×10^{23} mol^{-1}
Planck Constant = 6.63×10^{-34} J s
Specific Heat Capacity of water = 4.2 J g^{-1} K^{-1}
Speed of Light = 3×10^8 m s^{-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	–C**H**	Saturated alkanes
0.5–5.5	–O**H**	Alcohols
1.0–3.0	–N**H**	Amines
2.0–3.0	–CO–C**H**	Ketones
	–N–C**H**	Amines
	C_6H_5–C**H**	Arene (aliphatic on ring)
2.0–4.0	X–C**H**	X = Cl or Br (3.0–4.0)
		X = I (2.0–3.0)
4.5–6.0	–C=C**H**	Alkenes
5.5–8.5	RCON**H**	Amides
6.0–8.0	$-C_6\mathbf{H}_5$	Arenes (on ring)
9.0–10.0	–C**H**O	Aldehydes
10.0–12.0	–COO**H**	Carboxylic acids

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

New Specification

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GCE

CHEMISTRY DATA SHEET
GCE A/AS EXAMINATIONS
CHEMISTRY

Including the 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.

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						

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

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

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