Rewarding Learning

Centre Number

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

Chemistry

Assessment Unit AS 3
assessing
Module 3: Basic
Practical Chemistry

Practical Booklet B (Theory)

[SCH32]

SCH32

FRIDAY 1 JUNE, AFTERNOON

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 four** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 55.
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, containing some data, is included with this question paper.

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]

(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.

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____ [2]

(ii) Explain the purpose of inverting the volumetric flask.

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____ [1]

(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 $\pm$ 0.05 cm^3. Calculate the percentage uncertainty in the titre value, to one significant figure.

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____ [2]

(ii) State the colour change at the end point of the titration.

____ [2]

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

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____ [3]

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

____

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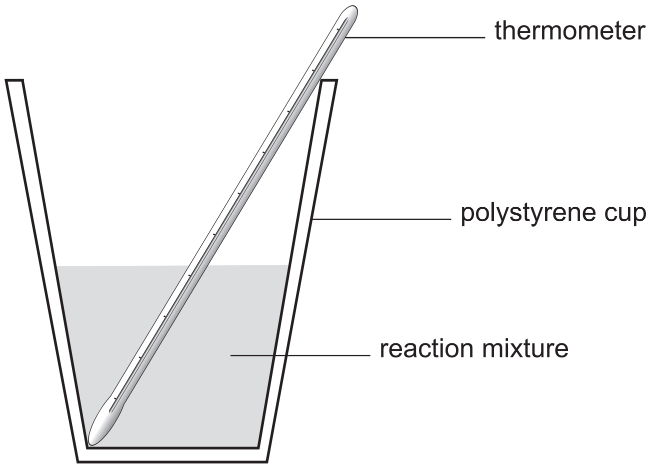
____ [2]

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 above that would minimise heat loss to the surroundings.

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______________________________ [2]

(ii) Define the term **standard enthalpy of neutralisation**.

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____

______________________________ [2]

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(iii) State the conditions used for standard enthalpy changes.

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____ [2]

(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]

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

____

____ [2]

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

____

____ [2]

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

____

____ [1]

(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.

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____ [1]

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

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____ [2]

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

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____ [2]

(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]

(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]

(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.

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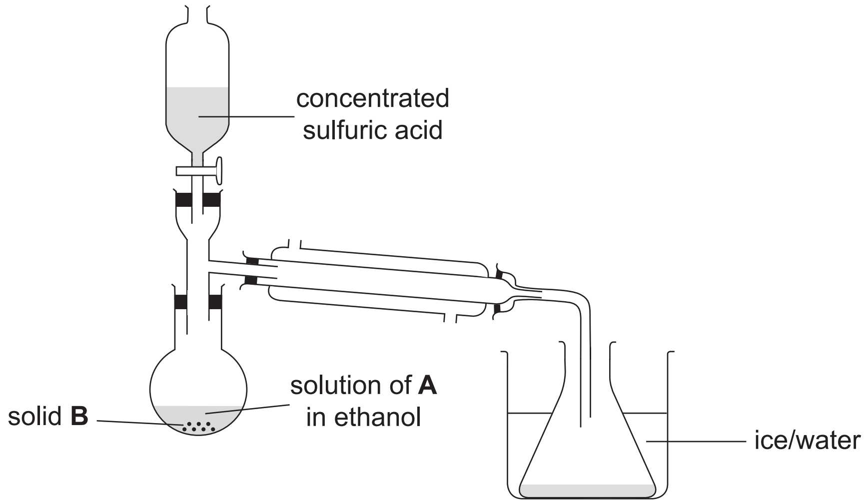
____ [3]

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]

(b) Suggest why a heat source is not required.

____ [1]

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

____ [1]

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

____ [1]

(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%.

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____ [5]

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

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____ [2]

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]

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

____

____ [2]

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

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____ [1]

(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]

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

____

____ [2]

THIS IS THE END OF THE QUESTION PAPER

DO NOT WRITE ON THIS PAGE

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

cea
Rewarding Learning

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 1	II 2	3	4	5	6	7	8	9	10	11	12	III 13	IV 14	V 15	VI 16	VII 17	0 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 x b	a = relative atomic mass (approx) x = atomic symbol b = atomic number