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.

_____

_____

_____ [2]

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

_____

_____ [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.

_____

_____

_____ [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.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [3]

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

_____

_____

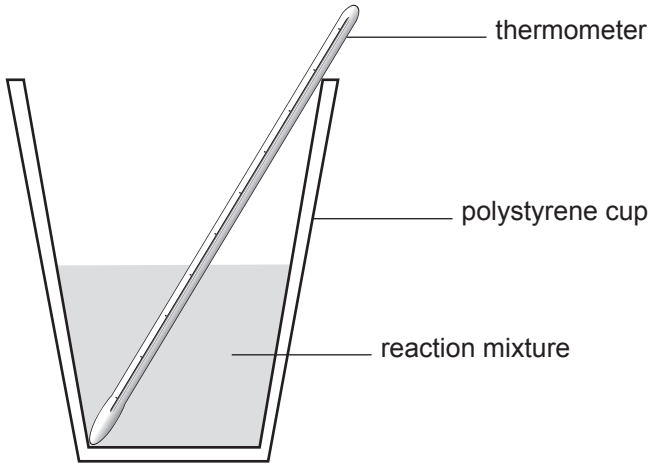
_____ [2]

**[Turn over**

**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.

_____

_____

_____ [2]

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

_____

_____

_____ [2]

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

_____

_____ [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]

**[Turn over**

**(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.

_____

_____ [1]

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

_____

_____ [2]

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

_____

_____ [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.

_____

_____

_____

_____

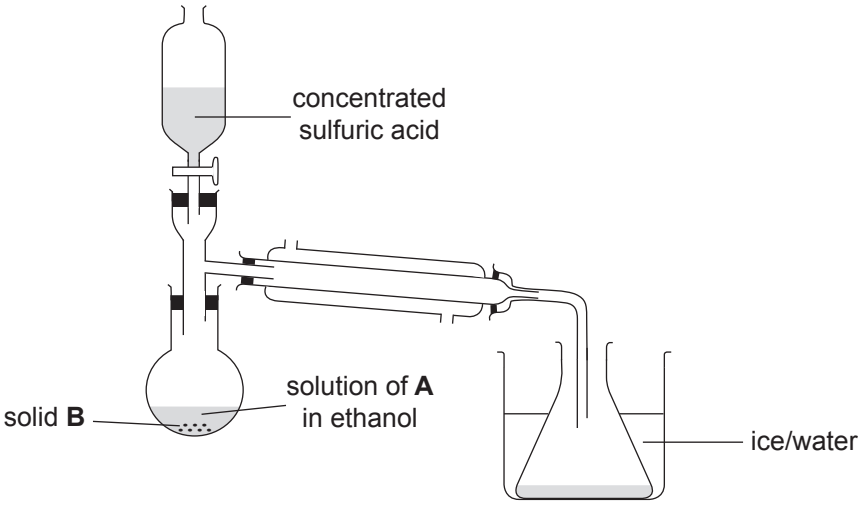
_____ [3]

**[Turn over**

**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%.

_____

_____

_____

_____

_____

_____

_____ [5]

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

_____

_____

_____

_____ [2]

**[Turn over**



**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.

_____

_____ [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 = $6.02 \times 10^{23}$ $mol^{-1}$
Planck Constant = $6.63 \times 10^{-34}$ J s
Specific Heat Capacity of water = 4.2 J $g^{-1}$ $K^{-1}$
Speed of Light = $3 \times 10^8$ 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 | –$C_6$**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

# 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

| | I | II | | | | | | | | | | | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group | | | | | | | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 1 | 1 H Hydrogen 1 | | | | | | | | | | | | | | | | | 4 He Helium 2 |
| 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 |
| 3 | 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 |
| 4 | 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 |
| 5 | 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 |
| 6 | 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 |
| 7 | 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
b x

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