



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2022

Centre Number

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Candidate Number

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Chemistry

Assessment Unit AS 3

assessing

Module 3: Practical Examination

Practical Booklet B (Theory)



[SCH32]

SCH32

WEDNESDAY 1 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 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 (including some data) is provided.

13004



12SCH3201

- 1 (a) Barium hydroxide is a Group II hydroxide. A sample of a saturated solution of barium hydroxide formed at 40 °C is heated to constant mass in an evaporating basin using a Bunsen burner.

The following mass measurements were taken:

Mass of evaporating basin = 45.27 g

Mass of evaporating basin and saturated solution = 61.50 g

Mass of evaporating basin and contents after heating to constant mass = 46.28 g

Calculate the solubility of barium hydroxide at 40 °C in g/100 g water based on the results of this experiment. Give your answer to 2 decimal places.

[3]

- (b) State the trends in the solubility of the Group II hydroxides and sulfates as the group is descended.

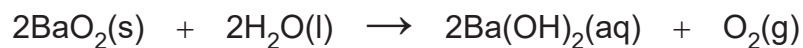
Group II hydroxides: _____

Group II sulfates: _____

[1]



(c) Barium hydroxide may be prepared by boiling a mixture of barium peroxide, BaO₂, and water. The equation for the reaction is:



2.00 g of an impure sample of barium peroxide were boiled with an excess of water and 117 cm³ of oxygen gas (measured at room temperature and pressure) were collected in a gas syringe.

(i) State the oxidation number of oxygen in each of the following:

BaO₂ _____

H₂O _____

Ba(OH)₂ _____

O₂ _____

[2]

(ii) Using the volume of oxygen gas collected, calculate the percentage of barium peroxide in the sample. Give your answer to 1 decimal place.

[3]

(iii) State the test for oxygen gas.

[1]

(iv) Describe, without experimental detail, how you would test the solution formed for barium ions.

[2]

[Turn over



2 Four samples of a **mixture** of dilute ethanoic acid and ethanol were tested as shown in the table below.

(a) Complete the observations column in the table.

| Sample | Test | Observations |
|--------|--|--|
| 1 | Add a half-spatula measure of solid sodium carbonate to 2 cm ³ of the mixture in a test tube. | effervescence test tube feels cool solid disappears solution remains colourless |
| 2 | Add a half-spatula measure of solid phosphorus pentachloride to 2 cm ³ of the mixture in a test tube. | |
| 3 | Add 2 cm ³ of acidified potassium dichromate(VI) solution to 2 cm ³ of the mixture in a test tube. Warm in a water bath. | |
| 4 | Add a 1 cm strip of magnesium ribbon to 5 cm ³ of the mixture in a test tube. | |

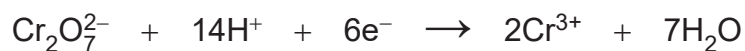
[5]



(b) State the IUPAC name of the organic product of the reaction between phosphorus pentachloride and ethanol.

_____ [1]

(c) Acidified potassium dichromate(VI) is an oxidising agent. The half equations for the oxidation of ethanol and reduction of dichromate(VI) ions are:



Write the ionic equation for the oxidation of ethanol using acidified dichromate(VI) ions.

_____ [2]



(ii) State and explain which indicator is used in this titration.

[1]

(iii) Calculate the relative formula mass of the acid.

[4]

(c) H_2A is a dicarboxylic acid as it contains two $-COOH$ groups. Deduce a structural formula for the acid.

[1]



4 Halogenoalkanes may be hydrolysed.

(a) The hydrolysis of halogenoalkanes using silver nitrate solution involves heating a mixture of the liquid halogenoalkane with aqueous silver nitrate and ethanol in a water bath at 50 °C. The halogenoalkanes are hydrolysed by the water in aqueous silver nitrate. The mechanism is nucleophilic substitution.

(i) Suggest why ethanol is added to the mixture.

_____ [1]

(ii) Write an equation for the hydrolysis of 1-bromobutane with water.

_____ [1]

(iii) Explain why water can act as a nucleophile.

_____ [1]

(b) The table below shows the time taken for a precipitate to form in the hydrolysis of the liquid halogenoalkanes using silver nitrate solution.

| Halogenoalkane | Time for a precipitate to form / s |
|-------------------------|------------------------------------|
| 1-chlorobutane | 565 |
| 1-bromobutane | 86 |
| 1-iodobutane | 46 |
| 2-bromobutane | 32 |
| 2-bromo-2-methylpropane | 4 |

(i) What is meant by the term **hydrolysis**?

_____ [1]



- (ii) State the colour of the precipitate formed when 2-bromo-2-methylpropane is hydrolysed using silver nitrate solution.

_____ [1]

- (iii) Identify the precipitate formed when 1-chlorobutane is hydrolysed using silver nitrate solution.

_____ [1]

- (iv) State and explain the trend in the relative rates of hydrolysis of the primary halogenoalkanes.

_____ [2]

- (v) Compare the relative rates of hydrolysis of primary, secondary and tertiary halogenoalkanes.

_____ [1]

[Turn over

13004



12SCH3209

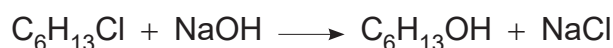
- (c) The following method may be used to hydrolyse 1-chlorohexane using sodium hydroxide solution.

10 cm³ of 1-chlorohexane were placed in a pear-shaped flask. 5 cm³ of 6.0 mol dm⁻³ sodium hydroxide solution (an excess) were added slowly whilst the flask was immersed in ice cold water. The mixture was heated under reflux for 20 minutes. The impure product, hexan-1-ol, was collected by fractional distillation between 150°C and 162°C. 4.4 cm³ of liquid were collected between these temperatures.

The table below gives the densities and boiling points of the organic reactant and product.

| Substance | Density /g cm ⁻³ | Boiling point /°C |
|----------------|-----------------------------|-------------------|
| 1-chlorohexane | 0.88 | 134 |
| hexan-1-ol | 0.82 | 157 |

The equation for the hydrolysis reaction is



- (i) Explain why the flask was immersed in ice cold water when the sodium hydroxide solution was being added.

_____ [1]

- (ii) Suggest why an excess of sodium hydroxide was used.

_____ [1]



(iii) Explain what is meant by heated under **reflux**.

[1]

(iv) What should be added to the reaction mixture to promote smooth boiling?

[1]

(v) Describe four changes which you would make to the apparatus used to heat under reflux, in order to carry out fractional distillation.

[4]

(vi) Assuming all of the liquid collected between 150 °C and 162 °C was hexan-1-ol, calculate the percentage yield. Give your answer to 1 decimal place.

[4]

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

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SCH32/5
260990



12SCH3212

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 dm³

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

Planck Constant = 6.63×10^{-34} Js

Specific Heat Capacity of water = $4.2 \text{ J g}^{-1} \text{ K}^{-1}$

Speed of Light = 3×10^8 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 |
| | C ₆ H ₅ –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 ₆ H 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.

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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

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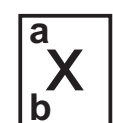
chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

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



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

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