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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.

1

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

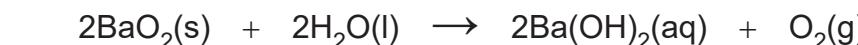
Group II hydroxides:

Group II sulfates: _____ [1]

10



- (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.	

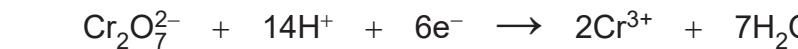
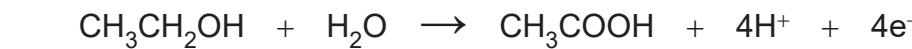
[5]



- (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]



- 3** 250 cm³ of a 7.00 g dm⁻³ solution of a dicarboxylic acid (represented by H₂A) was prepared from the solid acid.

(a) Describe how 250 cm³ of a solution of the acid was prepared from the solid acid.

1

- (b) H_2A reacts with sodium hydroxide solution according to the equation below:



25.0 cm³ portions of the solution of the acid were titrated with 0.145 mol dm⁻³ sodium hydroxide solution. The mean titre was 20.4 cm³.

- (i) State two ways you would ensure the end point of this titration is determined accurately.

1. _____

2. _____ [2]

1



(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 $-\text{COOH}$ 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



- (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



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Question Number	Marks
1	
2	
3	
4	

Total Marks	
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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 J g⁻¹ 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)
	–C=CH	Alkenes
4.5–6.0	RCONH	Amides
5.5–8.5	–C ₆ H ₅	Arenes (on ring)
6.0–8.0	–CHO	Aldehydes
9.0–10.0	–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

I II **THE PERIODIC TABLE OF ELEMENTS** 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 H Hydrogen																	4 He Helium
7 Li Lithium	9 Be Beryllium																2 Ne Neon
23 Na Sodium	24 Mg Magnesium																10 Ar Argon
39 K Potassium	40 Ca Calcium	45 Sc Scandium	48 Ti Titanium	51 V Vanadium	52 Cr Chromium	55 Mn Manganese	56 Fe Iron	59 Co Cobalt	59 Ni Nickel	64 Cu Copper	65 Zn Zinc	70 Ga Gallium	73 Ge Germanium	75 As Arsenic	79 Se Selenium	80 Br Bromine	84 Kr Krypton
85 Rb Rubidium	88 Sr Strontium	89 Y Yttrium	91 Zr Zirconium	93 Nb Niobium	96 Mo Molybdenum	98 Tc Technetium	101 Ru Ruthenium	103 Rh Rhodium	106 Pd Palladium	108 Ag Silver	112 Cd Cadmium	115 In Indium	119 Sn Tin	122 Sb Antimony	128 Te Tellurium	127 I Iodine	131 Xe Xenon
133 Cs Caesium	137 Ba Barium	139 La* Lanthanum	178 Hf Hafnium	181 Ta Tantalum	184 W Tungsten	186 Re Rhenium	190 Os Osmium	192 Ir Iridium	195 Pt Platinum	197 Au Gold	201 Hg Mercury	204 Tl Thallium	207 Pb Lead	209 Bi Bismuth	210 Po Polonium	210 At Astatine	222 Rn Radon
223 Fr Francium	226 Ra Radium	227 Ac[†] Actinium	261 Rf Rutherfordium	262 Db Dubnium	266 Sg Seaborgium	264 Bh Bohrium	277 Hs Hassium	268 Mt Meitnerium	271 Ds Darmstadtium	272 Rg Roentgenium	285 Cn Copernicium						

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

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

140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	145 Pm Promethium	150 Sm Samarium	152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium			
232 Th Thorium	231 Pa Protactinium	238 U Uranium	237 Np Neptunium	242 Pu Plutonium	243 Am Americium	247 Cm Curium	245 Bk Berkelium	251 Cf Californium	254 Es Einsteinium	253 Fm Fermium	256 Md Mendelevium	254 No Nobelium	257 Lr Lawrencium			