Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2022

Centre Number

Candidate Number

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.

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, BaO_2, and water. The equation for the reaction is:

$$2BaO_2(s) + 2H_2O(l) \longrightarrow 2Ba(OH)_2(aq) + O_2(g)$$

2.00 g of an impure sample of barium peroxide were boiled with an excess of water and 117 cm^3 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:

BaO_2 ____________

H_2O ____________

$Ba(OH)_2$ ____________

O_2 ____________ [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:

$$CH_3CH_2OH + H_2O \longrightarrow CH_3COOH + 4H^+ + 4e^-$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

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

____ [2]

[Turn over

3 250 cm^3 of a 7.00 g dm^{-3} solution of a dicarboxylic acid (represented by H_2A) was prepared from the solid acid.

(a) Describe how 250 cm^3 of a solution of the acid was prepared from the solid acid.

[6]

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

$$H_2A + 2NaOH \longrightarrow Na_2A + 2H_2O$$

25.0 cm^3 portions of the solution of the acid were titrated with 0.145 mol dm^{-3} sodium hydroxide solution. The mean titre was 20.4 cm^3.

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

1.

2.

[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]

[Turn over

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 cm^3 of 1-chlorohexane were placed in a pear-shaped flask. 5 cm^3 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 cm^3 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

$$C_6H_{13}Cl + NaOH \longrightarrow C_6H_{13}OH + NaCl$$

(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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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.

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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

gce a/as examinations

chemistry

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 X b

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