Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2024

Centre Number

Candidate Number

Chemistry

Assessment Unit AS 3
assessing
Module 3: Practical Examination
Practical Booklet B (Theory)

[SCH32]

SCH32

THURSDAY 30 MAY, 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 or a pencil.**
Answer **all five** 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 The table below shows the standard enthalpy of combustion of methanol and the theoretical and experimental temperature increases when 200 g of water is heated by burning 1 g of methanol and by burning 1 g of ethanol.

Alcohol	$\Delta_c H^{\ominus}$ /kJ mol^{-1}	Theoretical temperature increase /°C	Experimental temperature increase /°C
Methanol	–726	27	18
Ethanol		35	24

(a) Apart from safety equipment and apparatus used to support or clamp containers, name three essential pieces of apparatus which would be required to determine the experimental temperature increase.

1. _____

2. _____

3. _____ [3]

(b) Suggest one reason for the differences between the theoretical and experimental temperature changes.

_____

_____ [1]

(c) The standard enthalpy of combustion ($\Delta_c H^{\ominus}$) may be calculated from the theoretical temperature increase values.

(i) Define **standard enthalpy of combustion**.

_____

_____

_____ [2]

(ii) Calculate the standard enthalpy of combustion of ethanol from the theoretical temperature increase. Give your answer to 3 significant figures.

Answer _____ kJ mol^{-1} [4]

(d) Suggest why it is practically more difficult to determine the experimental temperature increases for the combustion of 1 g of the alkanes, methane and ethane.

_____

_____ [1]

[Turn over

2 A sample of 224 mg of an unknown solid metal hydrogencarbonate, $MHCO_3$, was dissolved in 100 cm^3 of deionised water. A 25.0 cm^3 portion of this solution was titrated against 0.0145 mol dm^{-3} sulfuric acid, using methyl orange as an indicator. The equation for the reaction and the results of the titration are given below.

$$2MHCO_3 + H_2SO_4 \longrightarrow M_2SO_4 + 2CO_2 + 2H_2O$$

	Rough titration	**First accurate titration**	**Second accurate titration**
Initial burette reading /cm^3	1.4	0.5	19.8
Final burette reading /cm^3	21.5	19.8	39.0
Titre /cm^3	20.1	19.3	19.2

(a) Calculate the mean titre. Give your answer to 1 decimal place.

Answer _____ cm^3 [1]

(b) Suggest why phenolphthalein is not a suitable indicator for this titration.

_____

_____ [1]

(c) State the colour change observed at the end point when methyl orange is used as the indicator for this titration.

From _____ to _____ [1]

(d) Suggest one advantage of using a conical flask rather than a beaker for a titration.

_____

_____ [1]

(e) (i) Calculate the number of moles of sulfuric acid that reacted in this titration.

Answer _____ [1]

(ii) Calculate the relative formula mass of $MHCO_3$. Give your answer to the nearest whole number.

Answer _____ [2]

(iii) Calculate the relative atomic mass of M.

Answer _____ [1]

(iv) Identify M.

_____ [1]

[Turn over

(f) Calculate the expected titre if this experiment was repeated with the same mass (224 mg) of a pure sample of caesium hydrogencarbonate, $CsHCO_3$. Give your answer to 1 decimal place.

Answer _____ cm^3 [3]

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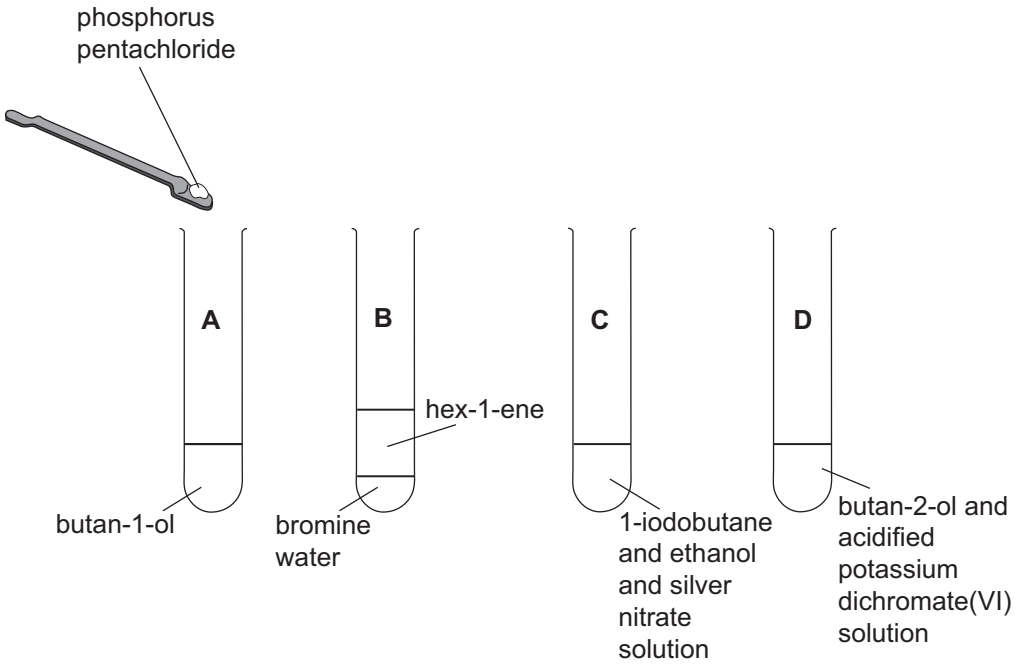
(Questions continue overleaf)

3 Four organic reactions were set up in boiling tubes labelled **A**, **B**, **C** and **D** as shown in the diagram below.



(a) (i) What would be observed in boiling tube **A** when phosphorus pentachloride is added to butan-1-ol?

_____

_____

_____ [2]

(ii) Write an equation for the reaction of phosphorus pentachloride with butan-1-ol.

_____ [1]

(b) Boiling tube **B** was stoppered and shaken and the contents allowed to settle.

(i) Explain why two layers form in boiling tube **B**.

_____

_____ [1]

(ii) What other observation would be made in boiling tube **B**?

_____

_____

_____ [1]

(iii) State the IUPAC name of the organic product in boiling tube **B**.

_____ [1]

(c) Boiling tube **C** was placed in a hot water bath and a precipitate formed almost immediately.

(i) State the colour of the precipitate.

_____ [1]

(ii) Write an ionic equation for the formation of the precipitate in boiling tube **C**.

_____ [1]

(iii) How would the observations differ if the 1-iodobutane in boiling tube **C** was replaced with 1-chlorobutane?

_____

_____ [2]

(d) Boiling tube **D** was also placed in a hot water bath.

(i) State the colour change observed in boiling tube **D**.

_____ [1]

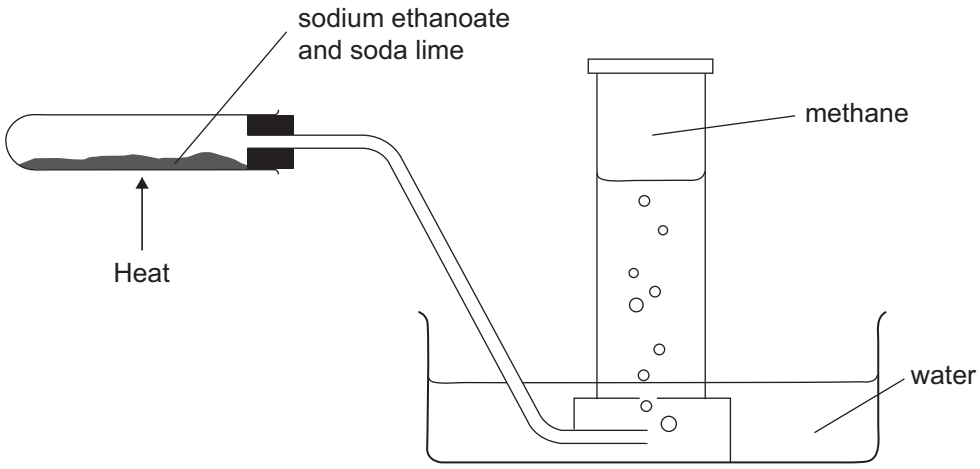
(ii) State the IUPAC name of the organic product in boiling tube **D**.

_____ [1]

[Turn over

4 The hydrides of the Period 2 and 3 elements include methane, ammonia, water and hydrogen chloride.

(a) The apparatus below may be used to prepare a sample of methane gas from the reaction of sodium ethanoate (CH_3COONa) and soda lime.



The equation for the reaction is given below where NaOH represents soda lime.

$$CH_3COONa + NaOH \longrightarrow CH_4 + Na_2CO_3$$

(i) Methane may be collected over water, as shown, or by upwards delivery. State one practical advantage of collecting methane over water.

_____

_____ [1]

(ii) Suggest the name of the gaseous product formed when sodium butanoate is heated with soda lime.

_____ [1]

(b) Ammonia reacts with chlorine to form ammonium chloride and nitrogen.

(i) Write an equation for this reaction.

_____ [2]

(ii) Describe the test for ammonia gas.

_____

_____

_____

_____ [2]

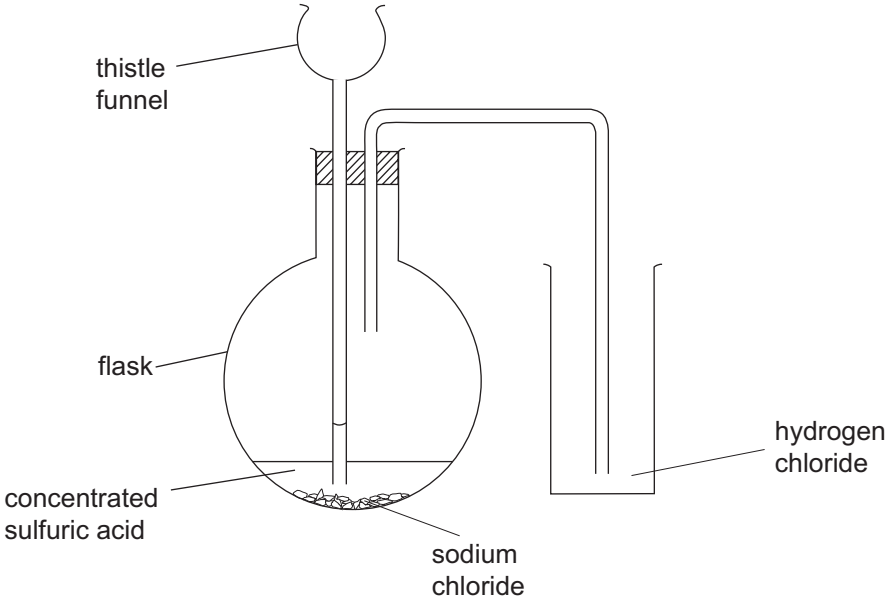
(iii) Complete the table below about the gaseous reactants in this reaction.

Gas	Colour of gas	Observations when gas tested with damp universal indicator paper
Ammonia	Colourless	
Chlorine		

[2]

[Turn over

(c) A diagram of the apparatus used to prepare and collect hydrogen chloride gas is shown below.



(i) Write an equation for the reaction to prepare hydrogen chloride.

_____ [1]

(ii) Explain why the bottom of the thistle funnel must be below the level of the concentrated sulfuric acid in the flask.

_____

_____ [1]

(iii) Sodium chloride is replaced with sodium iodide in the apparatus above. Name two gases formed during the reaction between sodium iodide and concentrated sulfuric acid.

1. _____

2. _____ [2]

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(Questions continue overleaf)

[Turn over

5 A student was purifying a sample of an organic liquid.

(a) The organic liquid was mixed with sodium hydrogencarbonate solution in a separating funnel. The separating funnel was stoppered and shaken.

(i) What is the purpose of shaking the organic liquid with sodium hydrogencarbonate solution?

_____

_____ [1]

(ii) What should the student do from time to time whilst shaking to release gas pressure?

_____

_____ [1]

(b) The contents of the separating funnel were allowed to stand until the layers settle. In the image below the student is preparing to separate the two layers.

Source: © Science Photo Library

(i) Why does the student remove the stopper before separating the layers?

_____

_____ [1]

(ii) How would the student check practically which is the aqueous layer, before separating the layers?

_____

_____ [2]

(c) When separated, the organic liquid contains some water.

(i) How does the water affect the appearance of the organic liquid?

_____ [1]

(ii) Name a suitable solid which the student could add to remove the water.

_____ [1]

(iii) How would the student remove this solid from the organic liquid?

_____

_____ [1]

THIS IS THE END OF THE QUESTION PAPER

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
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**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

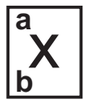
chemistry

THE PERIODIC TABLE OF ELEMENTS

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

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