Rewarding Learning

Centre Number

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Chemistry

Assessment Unit AS 3

assessing

Module 3: Practical Examination

Practical Booklet B (Theory)

[SCH32]

SCH32

WEDNESDAY 29 MAY, 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 three** questions.

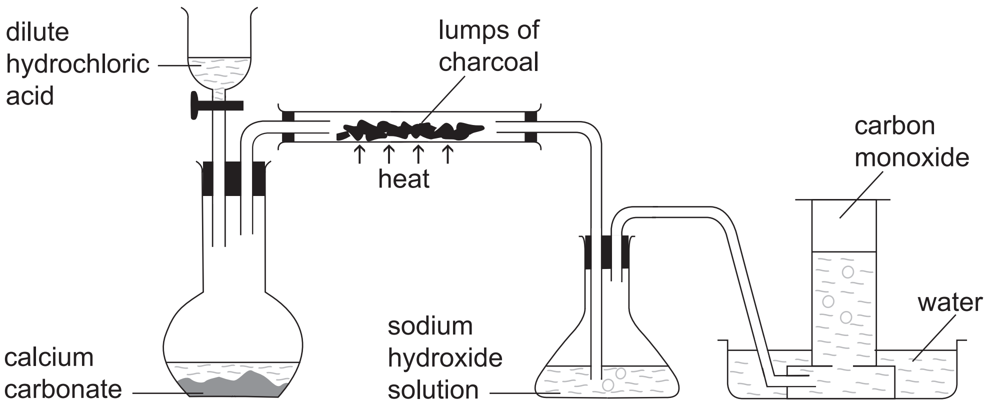
INFORMATION FOR CANDIDATES

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.

12184

1 Carbon monoxide is a toxic, colourless and odourless gas. Industrially, it is used to extract metals from their ores.

(a) In the laboratory, carbon monoxide can be made as shown in the apparatus below. Carbon dioxide is generated and passed over heated charcoal.



(i) Describe what is observed on addition of dilute hydrochloric acid to calcium carbonate.

____

____ [1]

(ii) Explain, using oxidation numbers, why charcoal can be described as a reducing agent, in the equation below.

$$CO_2 + C \longrightarrow 2CO$$

____

____ [2]

(iii) Using both collision theory and the concept of activation energy, explain how heating the charcoal will increase the rate of reaction.

____

____

____ [2]

12184

(iv) Suggest one reason why not all of the carbon dioxide reacts when passed over heated charcoal.

____

____ [1]

(v) Unreacted carbon dioxide is removed by reacting it with aqueous sodium hydroxide, to form sodium carbonate and water. Write the equation for this reaction.

____ [1]

(vi) Describe a test to identify the presence of carbonate ions in the aqueous solution.

____

____

____ [3]

(b) Carbon monoxide is used to extract iron from iron(**III**) oxide.

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

100 kg of iron(**III**) oxide was heated with 56 kg of carbon monoxide. Calculate the maximum mass, in kilograms, of iron produced.

____

____

____

____ [3]

(c) Carbon monoxide can be used to synthesise methanol as shown in the equation below.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad -91\,kJ$$

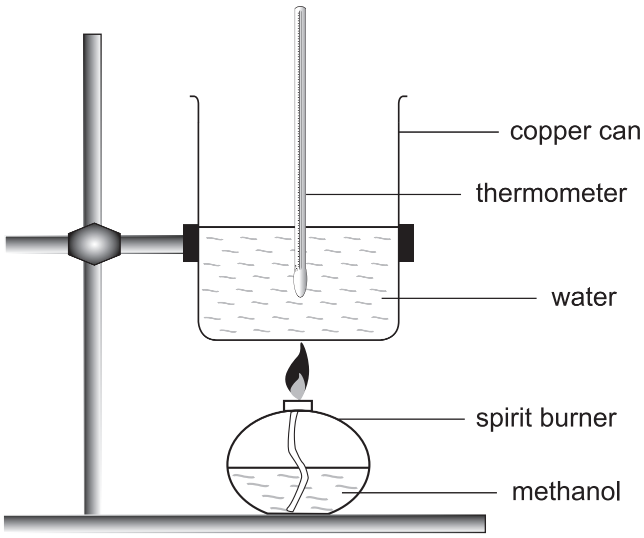
(i) State the effect of increasing temperature on the yield of methanol.

____ [1]

(ii) State the effect of increasing the pressure on the yield of methanol.

____ [1]

(d) The apparatus below can be used to determine the enthalpy of combustion of methanol. 100 g of water was placed in the copper can.



The following results were obtained.

mass of spirit burner and methanol before burning / g	20.33
mass of spirit burner and methanol after burning / g	18.92
initial temperature of water / °C	17.5
maximum temperature reached by water / °C	88.0

(i) Why is the water stirred throughout this experiment?

____ [1]

(ii) State **two** ways in which the apparatus could be improved to reduce heat loss.

____

____ [2]

(iii) Temperature is measured using a thermometer that has graduation marks at every 1 °C. The error for each temperature reading is ± 0.5 °C. Calculate the percentage error associated with the temperature change in the results obtained.

____ [2]

(iv) Using the results obtained, calculate the enthalpy of combustion of methanol.

____

____

____

____ [3]

(v) At the end of the experiment a black solid is seen coating the bottom of the copper can. Name this solid and explain how it is formed.

____

____ [2]

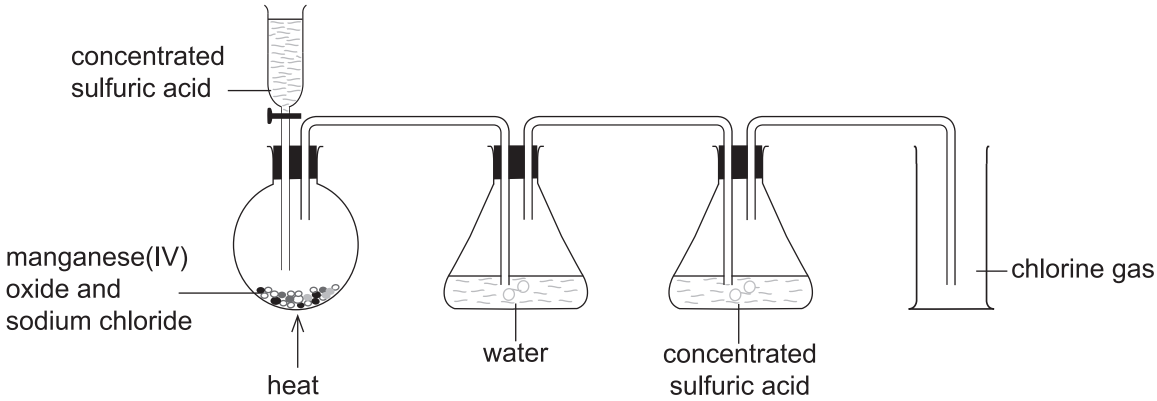
(vi) Explain, in terms of bonds, why the standard enthalpy of combustion of ethanol is greater than that of methanol.

____

____ [1]

[Turn over

2 Dry chlorine gas can be prepared by reacting hot concentrated sulfuric acid with a mixture of sodium chloride and manganese(IV) oxide (MnO_2).



(a) (i) In the first stage of the reaction the concentrated sulfuric acid reacts with sodium chloride to form hydrogen chloride gas. Write the equation for this reaction.

____ [1]

(ii) In the second stage the hydrogen chloride gas is oxidised by manganese(IV) oxide to form chlorine gas. Manganese(II) chloride and water are also formed. Write the equation for this reaction.

____ [2]

(iii) The chlorine gas produced in the round bottomed flask contains unreacted hydrogen chloride. How is this hydrogen chloride removed in the apparatus shown above?

____ [1]

(iv) The chlorine gas is collected by downward delivery. Suggest why chlorine is collected in this way.

____ [1]

(v) Describe the test that confirms the presence of chlorine gas.

____

____ [2]

(b) Chlorine can also be prepared by the reaction of sodium chlorate(I) with hydrochloric acid.

$$NaClO + 2HCl \longrightarrow NaCl + Cl_2 + H_2O$$

(i) 1 cm^3 of dilute hydrochloric acid is added to concentrated sodium chlorate(I) solution in a test tube. Explain why the solution turns pale green.

____ [1]

(ii) Outline a practical test that would confirm the presence of chloride ions in the reaction mixture.

____

____ [2]

(c) 1 cm^3 of hexane (density = 0.65 g cm^{-3}) was added to 10 cm^3 of a concentrated aqueous solution of chlorine in a test tube.

(i) What will be observed in the test tube to show that hexane and the aqueous solution are immiscible?

______________________________ [1]

(ii) The test tube is then stoppered and shaken and the contents allowed to settle. Suggest what is observed.

____

______________________________ [1]

(iii) The test tube is then placed under an ultraviolet light and removed after a period of time. Suggest what would be observed in the test tube.

____

______________________________ [1]

(iv) Name the piece of apparatus that could be used to separate the organic layer from the aqueous layer.

______________________________ [1]

(d) On reaction of 9.75 g of hexane with an excess of chlorine, in the presence of ultraviolet light, a mixture of products was formed including a chlorinated hydrocarbon **X**; 32.2 % of the mass of **X** is carbon and 4.5 % is hydrogen.

(i) Deduce the empirical formula of compound **X**.

____

____

____

____ [3]

(ii) The mass of compound **X** obtained was 2.54 g. Given that the percentage yield is 10 %, calculate the relative molecular mass of **X**.

____

____

____

____ [3]

(iii) Deduce the molecular formula of compound **X**.

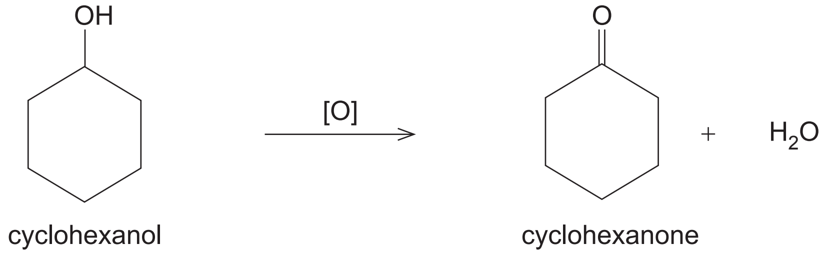
____ [1]

(iv) Explain why the reaction of hexane with an excess of chlorine produces a mixture of chlorinated hydrocarbons.

____

____ [1]

3 Cyclohexanone is manufactured on a large scale for the production of nylon. In the laboratory it can be prepared by refluxing cyclohexanol with concentrated sulfuric acid and excess sodium dichromate(VI). The mixture is then fractionally distilled. The crude distillate is a mixture of cyclohexanone and water.



	boiling point / °C	**density / g cm^{-3}**	**RMM**
cyclohexanol	161	0.96	100
cyclohexanone	156	0.95	98

(a) Define the term **reflux**.

____

____ [1]

(b) Outline a procedure which could be carried out to obtain a dry sample of cyclohexanone from the crude distillate.

____

____

____ [2]

(c) The oxidation of 20 cm^3 of cyclohexanol yielded 15 cm^3 of cyclohexanone. Calculate the percentage yield of cyclohexanone.

____

____

____

____ [3]

(d) State why the oxidation of cyclohexanol did not produce a carboxylic acid.

____ [1]

THIS IS THE END OF THE QUESTION PAPER

DO NOT WRITE ON THIS PAGE

243674

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.

COUNCIL FOR THE CURRICULUM, EXAMINATIONS AND ASSESSMENT
29 Clarendon Road, Clarendon Dock, Belfast BT1 3BG
Tel: +44 (0)28 9026 1200 Fax: +44 (0)28 9026 1234
Email: info@ccea.org.uk Web: www.ccea.org.uk

Rewarding Learning

New Specification

Rewarding Learning

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

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

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

$^{a}_{b}X$

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