Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

Candidate Number

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

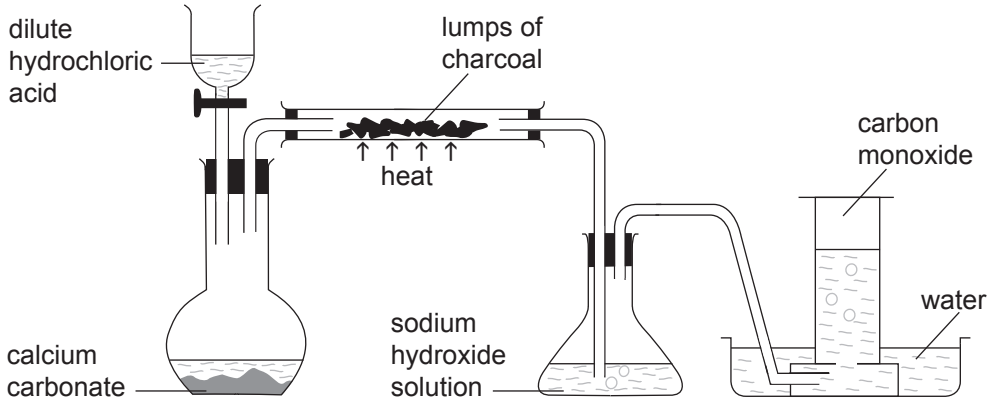
The total mark for this paper is 55.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

12184

12SCH3201

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]

(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]

[Turn over

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

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

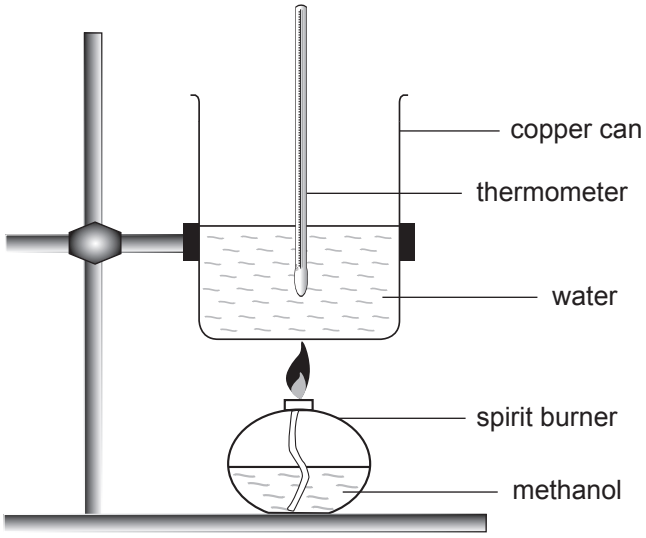
(i) State the effect of increasing temperature on the yield of methanol.

_____ [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]

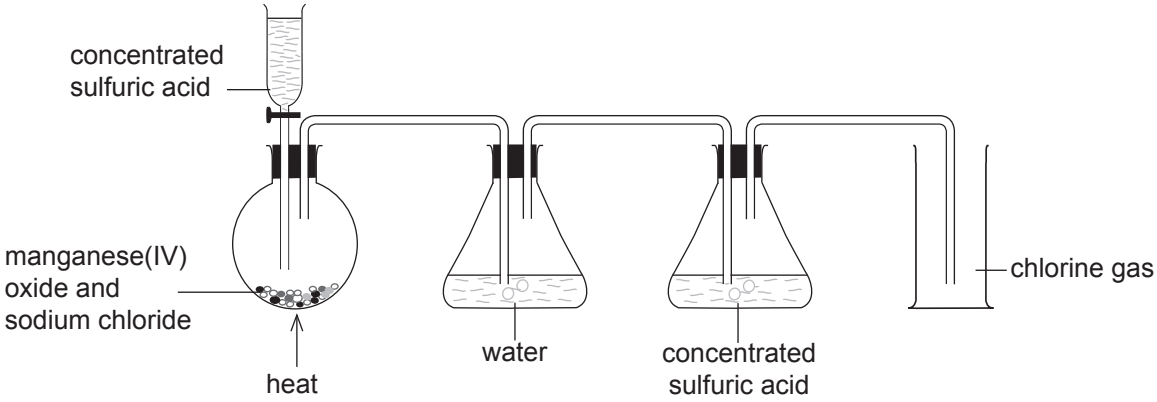
(vi) Explain, in terms of bonds, why the standard enthalpy of combustion of ethanol is greater than that of methanol.

_____

_____ [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]

[Turn over

(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]

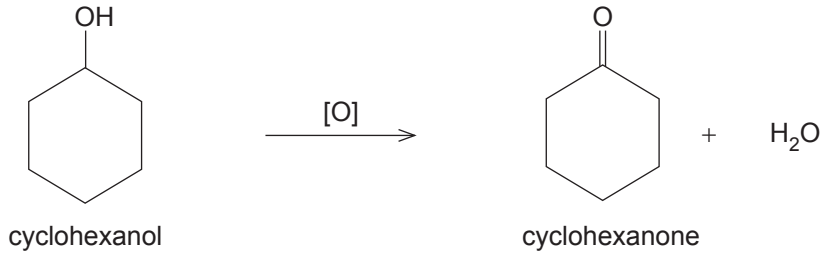
(iv) Explain why the reaction of hexane with an excess of chlorine produces a mixture of chlorinated hydrocarbons.

_____

_____ [1]

[Turn over

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

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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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Rewarding Learning

New Specification

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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

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