



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

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 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.

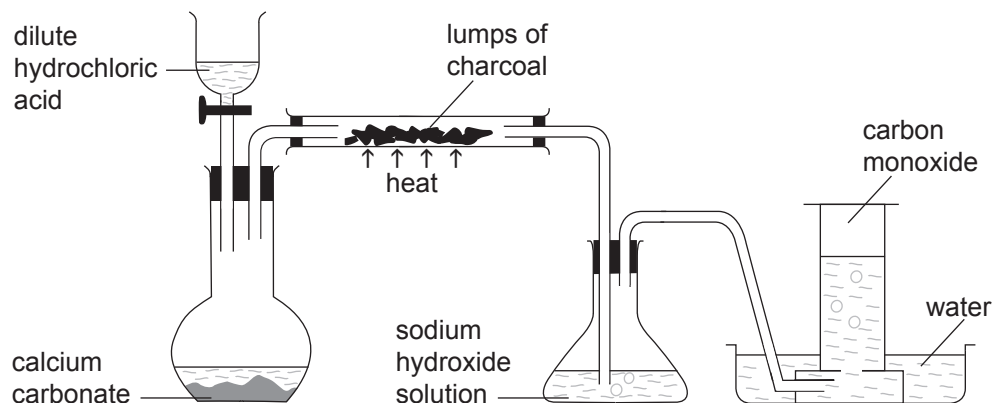
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A Periodic Table of Elements (including some data) is provided.



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

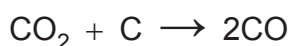
(a) In the laboratory, carbon monoxide can be made as shown in the apparatus below. Carbon dioxide is generated and passed over heated charcoal.



(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.



_____ [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]

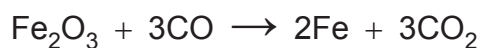
- (v) Unreacted carbon dioxide is removed by reacting it with aqueous sodium hydroxide, to form sodium carbonate and water. Write the equation for this reaction.

_____ [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.



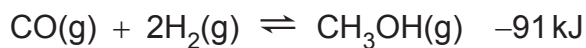
100 kg of iron(III) oxide was heated with 56 kg of carbon monoxide. Calculate the maximum mass, in kilograms, of iron produced.

_____ [3]

[Turn over



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



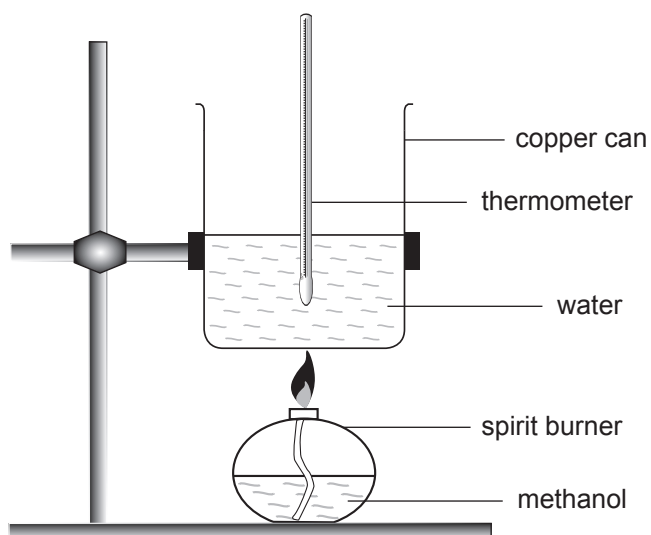
- (i) State the effect of increasing temperature on the yield of methanol.

_____ [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 $\pm 0.5^{\circ}\text{C}$. 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]

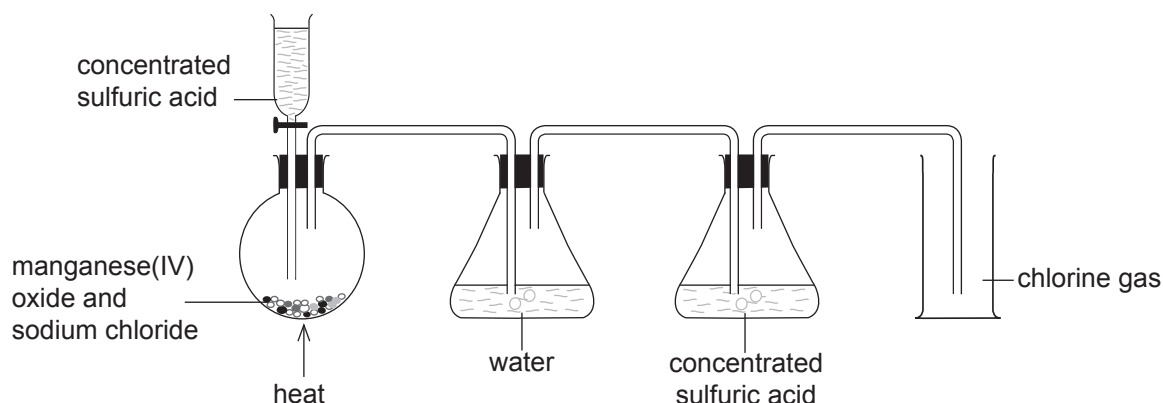
(vi) Explain, in terms of bonds, why the standard enthalpy of combustion of ethanol is greater than that of methanol.

_____ [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]



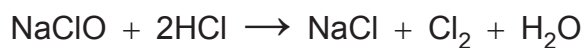
- (iv) The chlorine gas is collected by downward delivery. Suggest why chlorine is collected in this way.

_____ [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.



- (i) 1 cm³ 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 cm³ of hexane (density = 0.65 g cm⁻³) was added to 10 cm³ 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]

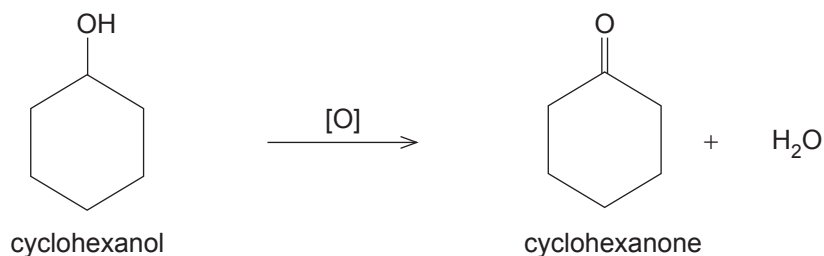
(iv) Explain why the reaction of hexane with an excess of chlorine produces a mixture of chlorinated hydrocarbons.

[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 cm³ of cyclohexanol yielded 15 cm³ 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 = $6.02 \times 10^{23} \text{ mol}^{-1}$

Planck Constant = $6.63 \times 10^{-34} \text{ Js}$

Specific Heat Capacity of water = $4.2 \text{ J g}^{-1} \text{ K}^{-1}$

Speed of Light = $3 \times 10^8 \text{ ms}^{-1}$

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_6H_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)
4.5–6.0	–C=CH	Alkenes
5.5–8.5	RCONH	Amides
6.0–8.0	– C_6H_5	Arenes (on ring)
9.0–10.0	–CHO	Aldehydes
10.0–12.0	–COOH	Carboxylic acids

These chemical shifts are concentration and temperature dependent and may be outside the ranges indicated above.

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

