Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

Candidate Number

Chemistry

Assessment Unit AS 3
assessing
Module 3: Practical Examination

MV18

Practical Booklet B (Theory)

[SCH32]

WEDNESDAY 29 MAY, AFTERNOON

Time

1 hour 15 minutes, plus your additional time allowance.

Instructions to Candidates

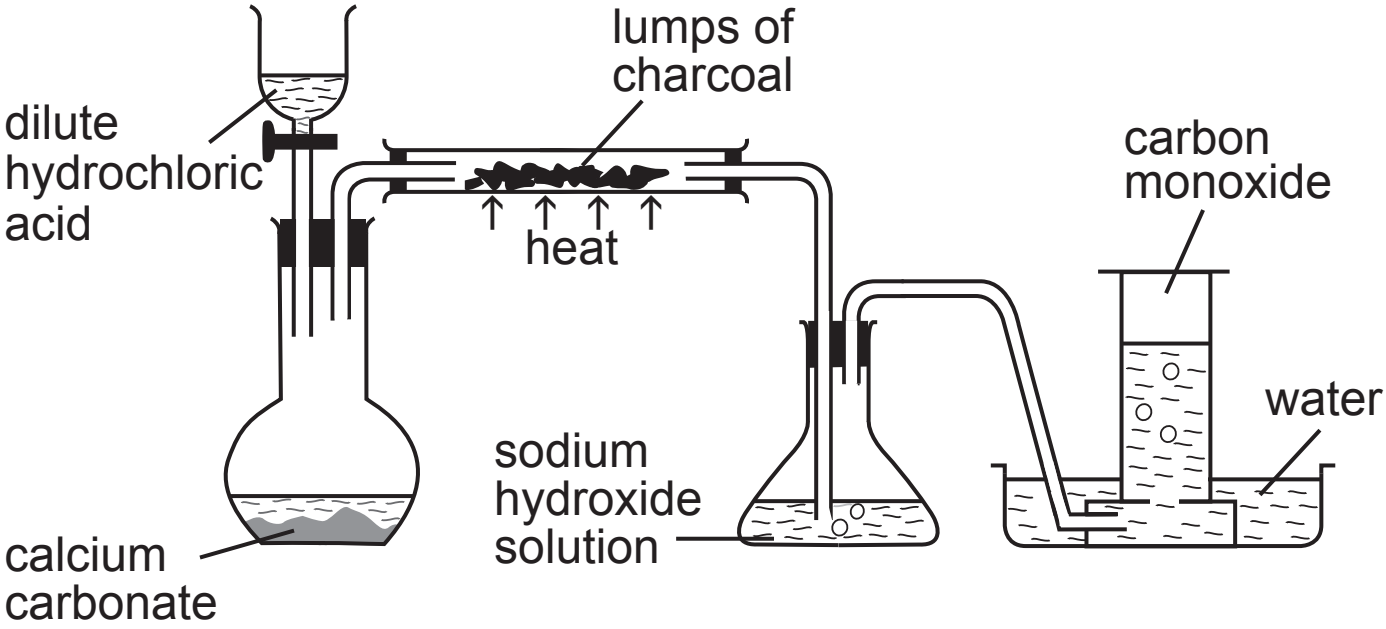
Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write on blank pages.
Complete in black ink only.
Answer **all three** questions.

Information for Candidates

The total mark for this paper is 55.
Figures in brackets printed at the end of each question 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 mark]

_____

_____

(ii) Explain, using oxidation numbers, why charcoal can be described as a reducing agent, in the equation below. [2 marks]

$CO_2 + C \rightarrow 2CO$

_____

_____

(iii) Using both collision theory and the concept of activation energy, explain how heating the charcoal will increase the rate of reaction. [2 marks]

(iv) Suggest one reason why not all of the carbon dioxide reacts when passed over heated charcoal. [1 mark]

(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 mark]

(vi) Describe a test to identify the presence of carbonate ions in the aqueous solution. [3 marks]

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

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

100 kg of iron(III) oxide was heated with 56 kg of carbon monoxide. Calculate the maximum mass, in kilograms, of iron produced. [3 marks]

(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 mark]

(ii) State the effect of increasing the pressure on the yield of methanol. [1 mark]

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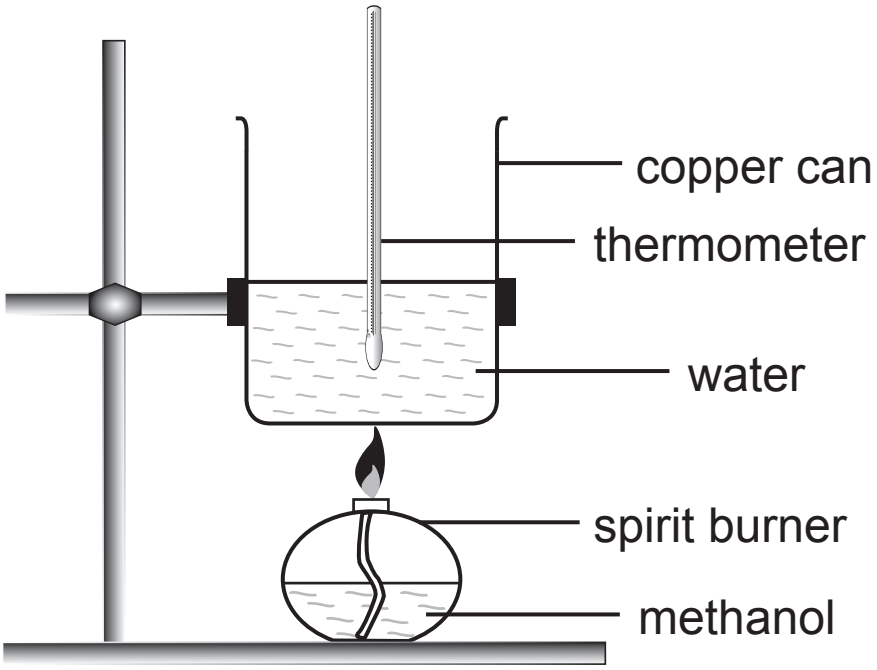
(Questions continue overleaf)

(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 mark]

_____

(ii) State **two** ways in which the apparatus could be improved to reduce heat loss. [2 marks]

_____

_____

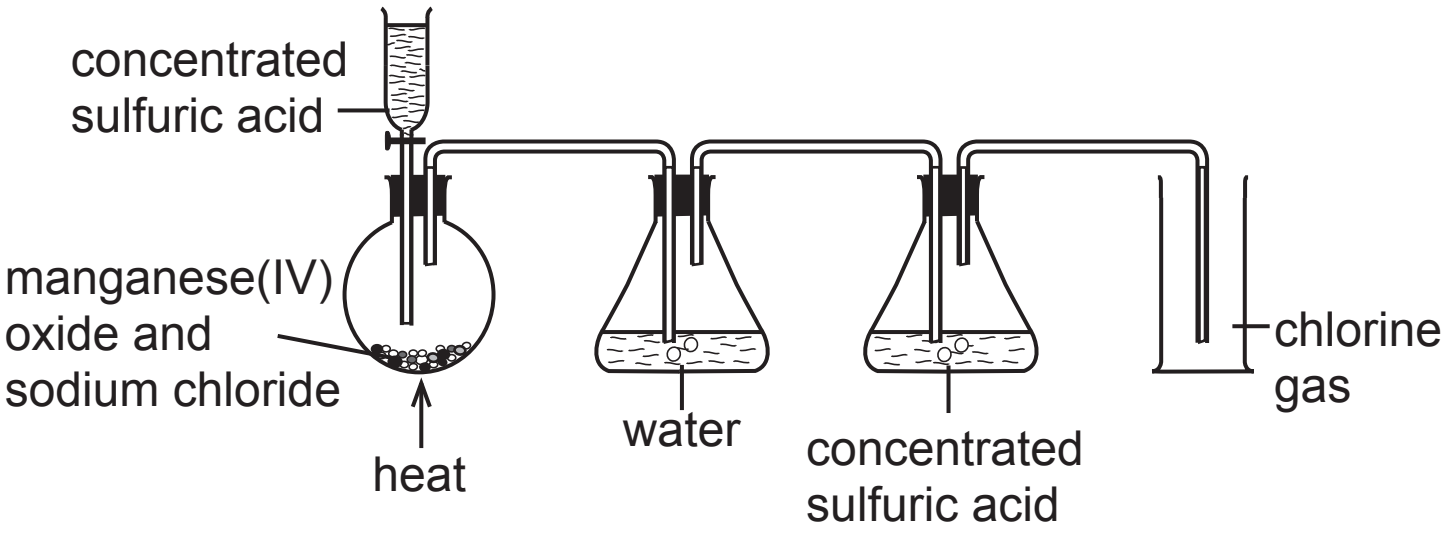
(iii) Temperature is measured using a thermometer that has graduation marks at every 1 °C. The error for each temperature reading is ± 0.5 °C. Calculate the percentage error associated with the temperature change in the results obtained. [2 marks]

(iv) Using the results obtained, calculate the enthalpy of combustion of methanol. [3 marks]

(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 marks]

(vi) Explain, in terms of bonds, why the standard enthalpy of combustion of ethanol is greater than that of methanol. [1 mark]

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 mark]

_____

(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 marks]

_____

(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 mark]

_____

(iv) The chlorine gas is collected by downward delivery. Suggest why chlorine is collected in this way. [1 mark]

(v) Describe the test that confirms the presence of chlorine gas. [2 marks]

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

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

(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 mark]

(ii) Outline a practical test that would confirm the presence of chloride ions in the reaction mixture. [2 marks]

(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 mark]

_____

(ii) The test tube is then stoppered and shaken and the contents allowed to settle. Suggest what is observed. [1 mark]

_____

_____

(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 mark]

_____

_____

(iv) Name the piece of apparatus that could be used to separate the organic layer from the aqueous layer. [1 mark]

_____

(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.

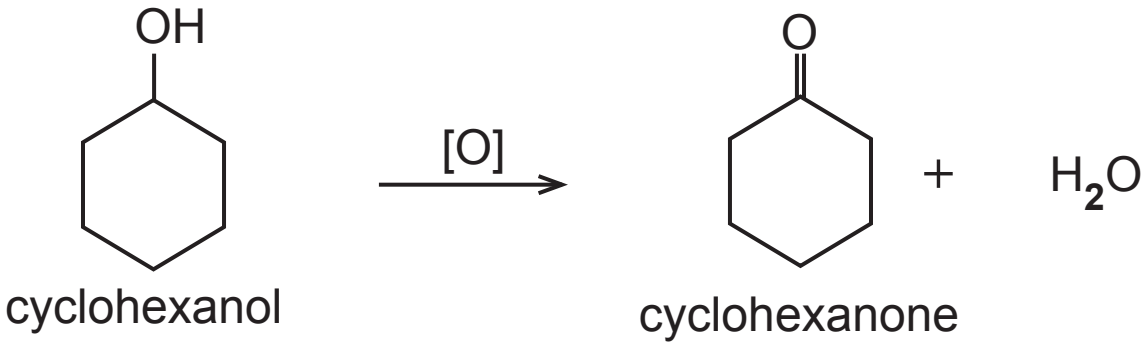
(i) Deduce the empirical formula of compound **X**. [3 marks]

(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 marks]

(iii) Deduce the molecular formula of compound **X**. [1 mark]

(iv) Explain why the reaction of hexane with an excess of chlorine produces a mixture of chlorinated hydrocarbons. [1 mark]

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.



cyclohexanol cyclohexanone

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

(a) Define the term **reflux**. [1 mark]

(b) Outline a procedure which could be carried out to obtain a dry sample of cyclohexanone from the crude distillate. [2 marks]

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

(d) State why the oxidation of cyclohexanol did not produce a carboxylic acid. [1 mark]

This is the end of the question paper

12184.03 **MV18**

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

Candidate Number

Chemistry

Assessment Unit AS 1
assessing
Basic Concepts in Physical
and Inorganic Chemistry

MV18

[SCH12]

MONDAY 20 MAY, MORNING

Time

1 hour 30 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all sixteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all six** questions in **Section B**. **You must answer the questions in the spaces provided.**
Do not write on blank pages.
Complete in black ink only.

Information for Candidates

The total mark for this paper is 90.
Quality of written communication will be assessed in Question **15(c)**.
In Section A all questions carry equal marks, i.e. **one** mark for each question.
In Section B the figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
A Periodic Table of Elements, containing some data, is included with this question paper.

Section A – Multiple Choice

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

Each multiple choice question is worth 1 mark.

1 In which of the following does chromium **not** have an oxidation state of +6?

A CrO_3

B CrO_4^{2-}

C $Cr_2O_7^{2-}$

D Cr_2O_3

2 Which bonding type is described as intermolecular?

A Covalent

B Ionic

C Metallic

D van der Waals' forces

3 Which of the following is the formula of the nitrite ion?

A N^{3-}

B NH_4^+

C NO_2^-

D NO_3^-

4 25.0 cm^3 of 0.10 M sodium hydroxide solution is exactly neutralised by

A 12.5 cm^3 of 0.05 M sulfuric acid.

B 25.0 cm^3 of 0.05 M sulfuric acid.

C 12.5 cm^3 of 0.20 M sulfuric acid.

D 25.0 cm^3 of 0.10 M sulfuric acid.

5 The electronic configuration of a Group III element is

A $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$.

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$.

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^2$.

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3$.

6 The bond angle in ammonia is

A 104.5°.

B 107°.

C 109.5°.

D 120°.

7 The sulfate(VI) ion can be reduced to sulfur dioxide.

$$SO_4^{2-} + xH^+ + ye^- \rightarrow SO_2 + zH_2O$$

Which of the following represents the correct values of x, y and z?

	x	y	z
A	2	2	4
B	2	4	2
C	4	2	2
D	4	4	2

8 Which type of titration can use phenolphthalein as a suitable indicator?

A Strong acid/strong base only

B Strong acid/strong base and weak acid/strong base

C Strong acid/strong base and strong acid/weak base

D Strong acid/weak base and weak acid/strong base

9 In which of the following molecules does the central atom obey the octet rule?

A BF_3

B $BeCl_2$

C ClF_3

D PH_3

10 Which species is the most powerful oxidising agent?

A Bromide

B Bromine

C Chloride

D Chlorine

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(Questions continue overleaf)

Section B

Answer **all six** questions in the spaces provided.

11 Water can act as an acid or as a base. It can either lose or gain hydrogen ions.

(a) State and explain the shape of a water molecule. [3 marks]

(b) Water can react with hydrogen ions forming hydroxonium ions, H_3O^+.

(i) Draw a dot and cross diagram to show the bonding in a hydroxonium ion, showing all the outer shell electrons. [2 marks]

(ii) Suggest why the bond angle in the hydroxonium ion is greater than the bond angle in water. [2 marks]

(iii) Suggest why the hydroxonium ion does not react with a hydrogen ion to form H_4O^{2+}. [1 mark]

12 Four new elements have recently been added to the Periodic Table. The four elements are given below, along with their atomic numbers and the mass numbers of their most common isotope.

element	**atomic number**	**mass number**
nihonium	113	286
moscovium	115	289
tennessine	117	294
oganesson	118	294

(a) What is the meaning of the following terms?

(i) Atomic number [1 mark]

(ii) Mass number [1 mark]

(iii) Isotopes [1 mark]

(b) State and explain which element has the most neutrons. [2 marks]

(c) Suggest why tennessine is placed in Group VII of the Periodic Table. [1 mark]

_____

(d) Erbium is a soft, silvery solid that tarnishes slowly in air. It is used in fibre optic cables. There are six known isotopes of erbium and its relative atomic mass is 167.26.

(i) Define the term **relative isotopic mass**. [2 marks]

_____

_____

(ii) The table below gives the percentage abundances of six isotopes in the mass spectrum of erbium.

relative isotopic mass	161.93	163.93	165.93		167.93	169.94
% abundance	0.14	1.60	33.50	22.87	26.98	14.91

Calculate the missing relative isotopic mass.
[3 marks]

_____

_____

_____

_____

13 Chloroauric acid, $HAuCl_4$, is an orange solid that is used widely in gold refining. During World War II, the Hungarian chemist George de Hevesy dissolved two gold Nobel Prize medals in a mixture of concentrated nitric and hydrochloric acids to prevent the Germans from confiscating them. Later the medals were reconstructed from the dissolved chloroauric acid and returned.

(a) The reaction between gold, concentrated hydrochloric acid and concentrated nitric acid produces chloroauric acid, nitrogen(IV) oxide and water. Write the equation for this reaction. [2 marks]

(b) Gold is extracted from recycled electronic materials by reaction with chlorine and hydrochloric acid, forming chloroauric acid. Elemental gold is recovered by electrolysis of chloroauric acid.

$$2Au + 3Cl_2 + 2HCl \rightarrow 2HAuCl_4$$

(i) Deduce the oxidation state of gold in chloroauric acid. [1 mark]

(ii) With reference to oxidation numbers, explain why this is a redox reaction. [3 marks]

(c) When heated, chloroauric acid forms gold(III) chloride and hydrogen chloride gas. The bonding in gold(III) chloride is considered to be covalent.

(i) Suggest, in terms of electronegativity, why the bonding in gold(III) chloride is covalent. [1 mark]

(ii) Describe the chemical test for hydrogen chloride gas. [2 marks]

14 The recommended daily allowance for salt, sodium chloride, is 6.0 g. Eating too much salt can lead to high blood pressure, potentially causing heart disease and strokes.

(a) State the electronic configuration of a sodium atom and use it to explain why sodium is regarded as an s-block element. [2 marks]

(b) (i) Define the term **Avogadro's constant**. [1 mark]

(ii) Calculate the number of sodium ions in the recommended daily allowance of sodium chloride. [2 marks]

(c) A solid sample of salt was analysed to confirm the identity of the ions present.
A flame test was first conducted on the sample using nichrome wire and concentrated hydrochloric acid to identify sodium ions. The presence of chloride ions was subsequently confirmed.

(i) State **two** reasons why **nichrome** wire was used. [2 marks]

(ii) State **two** reasons why concentrated hydrochloric acid was used. [2 marks]

(iii) State the colour observed in the flame test. [1 mark]

(d) Describe how the presence of chloride ions could be confirmed in the solid salt. [4 marks]

(e) A second salt sample was thought to be contaminated with sodium carbonate. Describe a chemical test to confirm the presence of carbonate ions. [3 marks]

(f) The salt sample, of mass 6.0 g, contaminated with sodium carbonate was dissolved in water. A solution of magnesium chloride was added, forming a precipitate of magnesium carbonate. The precipitate was filtered off and dried to give 1.4 g of magnesium carbonate.

(i) Draw a dot and cross diagram to show the bonding in magnesium chloride showing all the outer electrons. [2 marks]

(ii) Write the equation for the reaction between sodium carbonate and magnesium chloride. [2 marks]

(iii) Use the following headings to calculate the percentage of sodium carbonate in the salt sample. [6 marks]

Relative formula mass of magnesium carbonate

Number of moles of magnesium carbonate

Number of moles of sodium carbonate

Relative formula mass of sodium carbonate

Mass of sodium carbonate in the sample

Percentage of sodium carbonate in the sample

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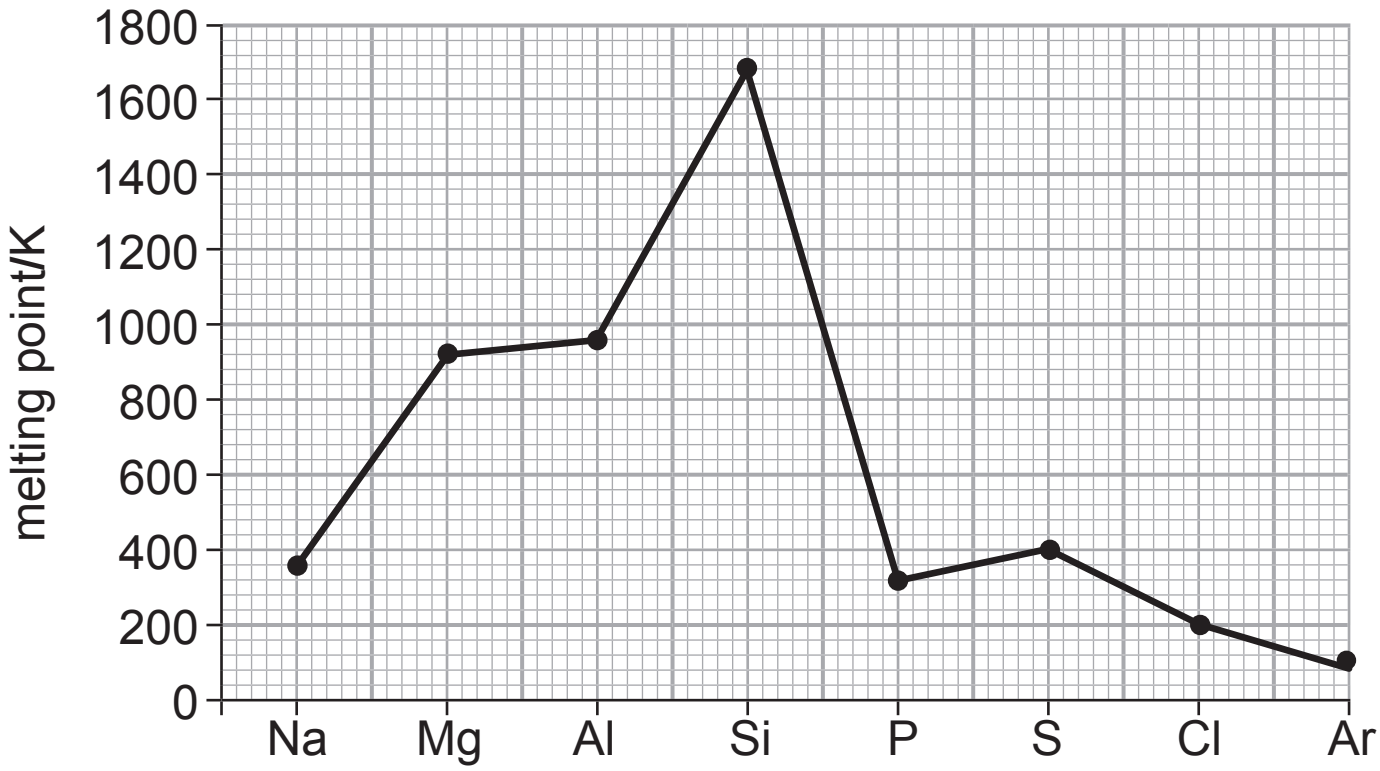
15 The third Period in the Periodic Table from sodium to argon displays a number of periodic trends.

(a) State and explain the general trend in first ionisation energy across Period three. [3 marks]

(b) (i) Write an equation, including state symbols, for the first ionisation energy of phosphorus. [2 marks]

(ii) Explain why the first ionisation energy of phosphorus is higher than that of sulfur. [2 marks]

(c) The graph below shows the melting points of the elements in the third Period.



With reference to the structure and bonding of the elements, explain the change in melting point from **silicon** to **argon**. [6 marks]

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

16 Lead(II) iodide is yellow and was once used as a pigment in paint until concerns over its toxicity led to its use being discontinued. It has a low solubility in water.

(a) Lead(II) iodide can be prepared by reaction between solutions of potassium iodide and lead(II) nitrate. Write the equation for this reaction. [2 marks]

(b) 75.6 mg of lead(II) iodide dissolve in 100 cm^3 of water at 20°C. Calculate the molarity of iodide ions in a saturated solution of lead(II) iodide at 20°C. [4 marks]

(c) Chlorine water was added to potassium iodide solution in a test tube.

(i) State the colour observed. [1 mark]

(ii) A solution of starch was then added to the test tube. State the colour observed. [1 mark]

(d) (i) State **three** observations made when concentrated sulfuric acid is added to solid potassium iodide.
[3 marks]

(ii) Explain why concentrated phosphoric acid does not give iodine when added to solid potassium iodide.
[1 mark]

THIS IS THE END OF THE QUESTION PAPER

11852.02 **MV18**

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

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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

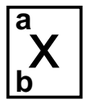
For first teaching from September 2016
For first award of AS Level in Summer 2017
For first award of A Level in Summer 2018
Subject Code: 1110

THE PERIODIC TABLE OF ELEMENTS

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