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ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2025

Centre Number

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Candidate Number

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Chemistry

StemUp Model Solution

Assessment Unit AS 1

assessing

Basic concepts in Physical
and Inorganic Chemistry



[SCH14]

SCH14

TUESDAY 13 MAY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

In **Section A**, answer each question by circling the appropriate letter below the question.

In **Section B**, you must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete questions in black ink and use a dark HB pencil for drawings and graphs.

Do not write with a gel pen.

Answer **all fifteen** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.

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

You may use a scientific calculator.

Quality of written communication will be assessed in Question **13(b)(iii)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

14551



Section A

For each of the following questions, only **one** of the lettered responses (A–D) is correct.

Select the correct response for each question by circling the appropriate letter below the question.

1 Which one of the following statements is correct?

- A Electronegativity increases down a group
- B First ionisation energy increases down a group
- C Phosphorus has a higher melting point than chlorine
- D The first ionisation energy of oxygen is greater than the first ionisation energy of nitrogen

Answer:

A

B

C

D

[1]

2 The two isotopes of chlorine, ^{37}Cl and ^{35}Cl , both form ions with a single negative charge. Which one of the following statements about these ions is correct?

- A Both ions have the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^5$
- B $^{37}\text{Cl}^-$ has more protons than $^{35}\text{Cl}^-$
- C The ions have different numbers of neutrons
- D The ions have different numbers of electrons

Answer:

A

B

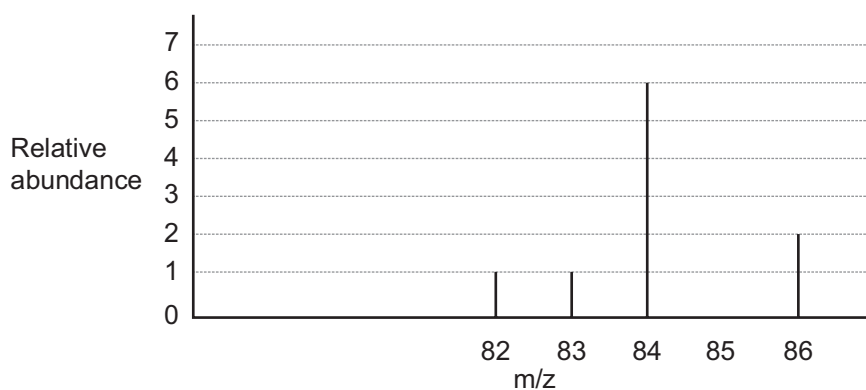
C

D

[1]



3 The mass spectrum of an element is shown below.



What is the relative atomic mass of the element to 1 decimal place?

- A 82.1
- B 83.1
- C 84.1
- D 86.1

Answer: A B **C** D [1]

4 Which one of the following does **not** have the same number of electrons as an atom of neon or an atom of argon?

- A O^{2-}
- B O_2
- C H_2O_2
- D OH^-

Answer: A **B** C D [1]

[Turn over]

14551



5 Which one of the following is the total number of ions in 11.6 g of magnesium hydroxide, $\text{Mg}(\text{OH})_2$?

- A 1.2×10^{23}
- B 1.8×10^{23}
- C 3.6×10^{23}
- D 6.0×10^{23}

Answer: A B **C** D [1]

6 A solid gives a brick red colour in a flame test and reacts with concentrated sulfuric acid to produce misty fumes, but no other gaseous products. The solid is:

- A calcium bromide
- B calcium chloride
- C lithium bromide
- D lithium chloride

Answer: A **B** C D [1]

7 When gallium undergoes its fourth ionisation, the electron is lost from the:

- A 3p subshell
- B 3d subshell
- C 4s subshell
- D 4p subshell

Answer: A **B** C D [1]

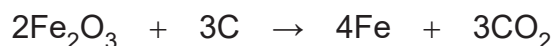


8 Which one of the following statements is correct for fluorine?

- A It acts as a reducing agent when it reacts with Group I metals
- B Its first ionisation energy is lower than its second ionisation energy
- C It has a lower electronegativity than oxygen
- D It has a monatomic structure

Answer: A ☒ B C D [1]

9 What is the maximum mass of iron, in kg, that can be produced from 900 kg of iron(III) oxide and 94.5 kg of carbon in the following reaction?



- A 315
- B 441
- C 588
- D 630

Answer: A B ☒ C D [1]

10 An element has the following successive ionisation energies, in kJ mol^{-1} :

787, 1577, 3232, 4356, 16091, 19806

Which one of the following statements is correct?

- A The chemical reactions of the element are similar to the chemical reactions of oxygen
- B The element forms $3+$ ions
- C The element is in Group I of the Periodic Table
- D An atom of the element has 4 electrons in its outer shell

Answer: A B C ☒ D [1]

[Turn over]

14551



Section B

Answer **all five** questions in this section.

11 (a) Complete the following table.

Name	Formula
sodium thiosulfate	$\text{Na}_2\text{S}_2\text{O}_3$
<i>calcium phosphate</i>	$\text{Ca}_3(\text{PO}_4)_2$
potassium nitrite	KNO_2
<i>ammonium chromate</i>	$(\text{NH}_4)_2\text{CrO}_4$

[4]

(b) Chromium(III) sulfate is used in tanning leather. It is soluble in water. At high temperatures it decomposes to give chromium(III) oxide, sulfur dioxide and oxygen.

(i) Write an equation for this decomposition reaction.



(ii) Describe a test to confirm the presence of sulfate ions in a sample of solid chromium(III) sulfate.

Dissolve some of the solid in deionised water to make a solution.

Add dilute hydrochloric acid and then barium chloride solution.

A white precipitate (of barium sulfate) forms.

[3]

(iii) What is the systematic name for sulfur dioxide?

sulfur(IV) oxide [1]



(iv) Describe the test for oxygen gas.

Put a glowing splint into the gas: it relights.

[1]

[Turn over]

14551



12 The halogens are in Group VII of the Periodic Table. The first ionisation energy of the elements decreases down the group.

(a) Write an equation which represents the first ionisation energy of chlorine.



(b) Explain the trend in first ionisation energy of the elements down Group VII.

Down the group the atoms get larger, so the outermost electron is
further from the nucleus.

There is also more shielding by inner shells, so the outer electron is
held less strongly and less energy is needed to remove it. [2]

(c) The boiling points of the elements increase down Group VII. Explain this trend in boiling point.

Down the group the RMM (number of electrons) of the molecules
increases.

So the van der Waals' forces between the molecules get stronger and
more energy is needed to overcome them.

[2]



(d) The trend in oxidising ability of the halogens can be determined by mixing aqueous solutions of halogens with aqueous solutions of potassium halide salts.

(i) Complete the following table, using a tick (✓) or a cross (X), to indicate whether a reaction occurs or not. One row has been completed for you.

potassium halide \ halogen	potassium chloride	potassium bromide	potassium iodide
chlorine		✓	✓
bromine	X		✓
iodine	X	X	

[1]

(ii) State the colour change observed in the solution when aqueous chlorine is added to potassium bromide solution.

From colourless to yellow-orange [1]

(iii) Write the ionic equation for the reaction between chlorine and potassium bromide.

$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ [1]

(iv) Silver nitrate solution and dilute ammonia solution can be used to identify and confirm the presence of halide ions in solution. Describe how both solutions can be used to confirm that no bromide ions remain in the solution when the reaction in (d)(iii) is complete.

Add silver nitrate solution to a sample of the final solution: a

white precipitate of silver chloride forms.

Then add dilute ammonia solution to the precipitate.

The precipitate fully dissolves and none remains, so there is no

(cream) silver bromide and no bromide ions are left. [3]

[Turn over]



(e) Solid sodium chloride and solid sodium bromide react with concentrated phosphoric acid and both reactions give the same observation. However, concentrated sulfuric acid can be used to distinguish between the two solid halides.

(i) State the observation made when concentrated phosphoric acid is added separately to solid sodium chloride and to solid sodium bromide.

Steamy (misty) fumes are seen in both. [1]

(ii) State the observation which can be used to distinguish between the two halides when concentrated sulfuric acid is added separately to solid sodium chloride and to solid sodium bromide.

Only sodium bromide gives a red-brown vapour. [1]

(iii) Name all the products formed when concentrated sulfuric acid reacts with solid sodium bromide.

sodium hydrogensulfate, hydrogen bromide, bromine, sulfur dioxide

and water

[3]

(iv) Explain why more products form in the reaction between concentrated sulfuric acid and solid sodium bromide than in the reaction between concentrated sulfuric acid and solid sodium chloride.

Bromide ions are stronger reducing agents than chloride ions, so

they can reduce concentrated sulfuric acid (to sulfur dioxide)

while being oxidised to bromine.

[1]



- (f) The concentration of a solution of sodium bromide is 6.5 mg in 100 cm³ of water. Calculate the molarity of the sodium bromide solution. Give your answer to 2 significant figures.

$$6.5 \text{ mg} = 0.0065 \text{ g}$$

$$\text{moles NaBr} = 0.0065 \div 103 = 6.311 \times 10^{-5} \text{ mol in } 100 \text{ cm}^3$$

$$\text{in } 1000 \text{ cm}^3: 6.311 \times 10^{-5} \times 10 = 6.311 \times 10^{-4} \text{ mol}$$

$$\text{molarity} = 6.3 \times 10^{-4} \text{ M}$$

Answer 6.3×10^{-4} M [3]



13 (a) Chlorine trifluoride, ClF_3 , is an extremely reactive interhalogen compound used in the semiconductor industry.

(i) Suggest the meaning of the term 'interhalogen' compound.

A compound made of two or more different halogens bonded together.

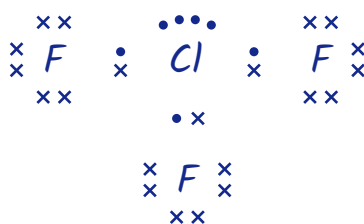
[1]

(ii) What is the oxidation number of chlorine in chlorine trifluoride?

+3

[1]

(iii) Draw a dot and cross diagram to show the bonding in a molecule of chlorine trifluoride. Show outer electrons only.



[1]

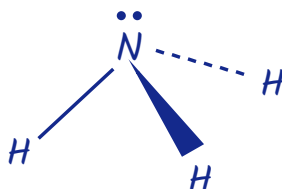
(b) Chlorine trifluoride reacts with ammonia to form nitrogen, chlorine and hydrogen fluoride.

(i) Write an equation for this reaction.



[2]

(ii) Draw the shape of a molecule of ammonia.



trigonal pyramidal, 107°

[1]



- (iii) A molecule of ammonia can gain a hydrogen ion to form an ammonium ion, NH_4^+ , or it can lose a hydrogen ion to form an azanide ion, NH_2^- .

State and explain the shape of an ammonium ion and the shape of an azanide ion. Include in your answer the approximate bond angles.

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

ammonium ion, NH_4^+

In the ammonium ion the nitrogen atom is surrounded by four

bonding pairs of electrons and no lone pairs.

Electron pairs repel each other and move as far apart as possible

to minimise repulsion; the four bonding pairs repel equally.

So the ammonium ion is tetrahedral with a bond angle of 109.5° .

azanide ion, NH_2^-

In the azanide ion the nitrogen atom has two bonding pairs and

two lone pairs of electrons.

Lone pairs repel more strongly than bonding pairs, so the two

bonding pairs are pushed closer together.

So the azanide ion is bent (V-shaped) with a bond angle of

about 104.5° .

[6]

[Turn over



14 Sulfur reacts with metals and with non-metals.

- (a) Sulfur reacts with hydrogen to form hydrogen sulfide. Hydrogen sulfide can be oxidised to sulfur by nitric acid.

- (i) State the observation which would indicate the presence of hydrogen sulfide.

A smell of rotten eggs.

[1]

- (ii) Hydrogen sulfide and water are Group VI hydrides. Compare the boiling point of hydrogen sulfide with the boiling point of water and explain the difference.

Hydrogen sulfide has a lower boiling point than water.

Water has hydrogen bonds between its molecules.

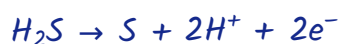
H₂S molecules only have van der Waals' forces / permanent

dipole-dipole attractions, which are weaker than hydrogen bonds,

so less energy is needed.

[3]

- (iii) Write a half-equation for the oxidation of hydrogen sulfide to sulfur.



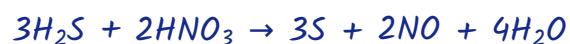
[1]

- (iv) Write a half-equation for the reduction of nitric acid to nitrogen(II) oxide.



[1]

- (v) Combine the two half-equations from (a)(iii) and (a)(iv) to give the overall redox equation for the reaction between hydrogen sulfide and nitric acid.



[1]



(b) Sulfur reacts with sodium to form the ionic compound, sodium sulfide.

(i) Describe the bonding and structure of sodium.

*Metallic bonding: a giant lattice of layers of positive sodium ions
in a sea of delocalised electrons.*

*The bonding is the attraction between the positive ions and the
delocalised electrons.*

[2]

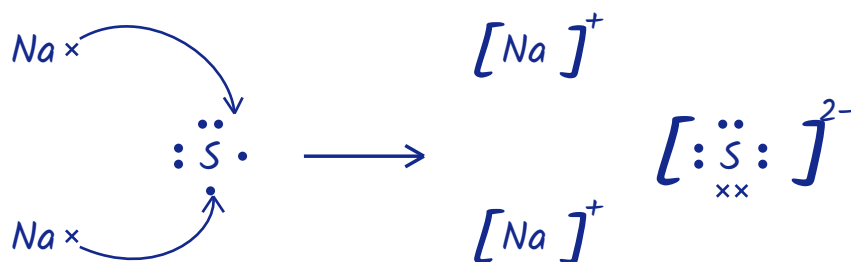
(ii) Write the electronic configurations of an atom of sodium and an atom of sulfur.

sodium: $1s^2 2s^2 2p^6 3s^1$

sulfur: $1s^2 2s^2 2p^6 3s^2 3p^4$

[2]

(iii) Draw a dot and cross diagram, using outer electrons only, to show the formation of sodium sulfide from atoms of sodium and sulfur.



[2]

[Turn over]



(iv) Hydrated sodium sulfide ($\text{Na}_2\text{S} \cdot x\text{H}_2\text{O}$) is used in the Kraft process for the conversion of wood into wood pulp, the main component of paper. A sample of hydrated sodium sulfide contains 59% sodium sulfide by mass. Calculate the value of x in the sample of hydrated sodium sulfide.

$$\text{In } 100 \text{ g: } \text{Na}_2\text{S} = 59 \text{ g and } \text{H}_2\text{O} = 100 - 59 = 41 \text{ g}$$

$$\text{moles } \text{Na}_2\text{S} = 59 \div 78 = 0.756$$

$$\text{moles } \text{H}_2\text{O} = 41 \div 18 = 2.28$$

$$x = 2.28 \div 0.756 = 3.01, \text{ so } x = 3$$

Answer 3 [3]



(c) Sulfur reacts with carbon to form carbon disulfide which has a molecular covalent structure. A molecule of carbon disulfide has a shape similar to that of carbon dioxide.

(i) Explain why carbon disulfide does not conduct electricity.

There are no delocalised electrons or ions, so nothing can move to carry charge.

[1]

(ii) Carbon disulfide contains polar bonds. Define the term **polar bond**.

A covalent bond in which the bonding electrons are shared unequally.

[1]

(iii) State and explain whether a charged rod would deflect a stream of carbon disulfide flowing from a burette.

Not deflected: CS₂ is linear (symmetrical), so the bond dipoles cancel and the molecule is non-polar.

[1]

[Turn over]



15 The identity of M in an unknown anhydrous metal carbonate, M_2CO_3 , may be determined by titration. A solution containing 2.60 g of M_2CO_3 in 500 cm^3 of deionised water was prepared and portions of this solution were titrated against a standard solution of hydrochloric acid.

- (a) Describe how the 500 cm^3 solution of M_2CO_3 was prepared from 2.60 g of solid M_2CO_3 .

Dissolve the 2.60 g of solid in a small volume of deionised water in a beaker, stirring with a glass rod.

Transfer the solution to a 500 cm^3 volumetric flask, with all the rinsings of the beaker and rod.

Make up to the mark by adding deionised water until the bottom of the meniscus is on the mark.

Stopper the flask and invert it several times to mix thoroughly.

[5]

- (b) (i) Define the term **standard solution**.

A solution of accurately known concentration.

[1]

- (ii) Before use in the titration, a sample of 50.0 cm^3 of 0.175 mol dm^{-3} hydrochloric acid was diluted to obtain a solution of concentration 0.100 mol dm^{-3} .

Calculate the volume of deionised water, in cm^3 , required to dilute the hydrochloric acid. Give your answer to 3 significant figures.

$$\text{moles HCl} = 50.0 \times 0.175 \div 1000 = 0.00875\text{ mol}$$

$$\text{total volume} = 0.00875 \times 1000 \div 0.100 = 87.5\text{ cm}^3$$

$$\text{water needed} = 87.5 - 50.0 = 37.5\text{ cm}^3$$

Answer 37.5 cm^3 [3]



- (c) In the titration, 25.0 cm^3 portions of the solution of the weak base, M_2CO_3 , were titrated against 0.100 mol dm^{-3} hydrochloric acid. A mean titre of 24.5 cm^3 was obtained. The equation for the reaction may be represented by:



- (i) State and explain which indicator is required for use in this titration and give the colour change at the end point.

Indicator: methyl orange

Explanation: It is a strong acid against a weak base titration,

so methyl orange changes colour at the end point pH.

Colour change at end point:

From yellow to red [3]

- (ii) Determine the identity of M in M_2CO_3 using the mean titre and the mass of solid M_2CO_3 .

$$\text{moles HCl} = 24.5 \times 0.100 \div 1000 = 0.00245$$

$$\text{moles M}_2\text{CO}_3 \text{ in } 25.0\text{ cm}^3 = 0.00245 \div 2 = 0.001225$$

$$\text{moles M}_2\text{CO}_3 \text{ in } 500\text{ cm}^3 = 0.001225 \times 20 = 0.0245$$

$$\text{RFM of M}_2\text{CO}_3 = 2.60 \div 0.0245 = 106$$

$$\text{RAM of M} = (106 - 12 - 48) \div 2 = 46 \div 2 = 23$$

so M is sodium

Answer sodium, Na [4]

- (d) Metal carbonates, such as M_2CO_3 , are often used in their hydrated form. State and explain the effect, if any, on the mean titre in this titration if 2.60 g of hydrated M_2CO_3 were used rather than the anhydrous form of M_2CO_3 .

The mean titre would be lower, as 2.60 g of hydrated M_2CO_3 contains

less M_2CO_3 (fewer moles). [2]



THIS IS THE END OF THE QUESTION PAPER

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For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
Total Marks	

Examiner Number

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SCH14/6
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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 dm³

Avogadro Constant = 6.02×10^{23} mol⁻¹

Planck Constant = 6.63×10^{-34} Js

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

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



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	–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 ₆ H 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 ₆ H 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.

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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																		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																	4 He Helium							
7 Li Lithium	9 Be Beryllium											11 B Boron	12 C Carbon	14 N Nitrogen	16 O Oxygen	19 F Fluorine	20 Ne Neon							
23 Na Sodium	24 Mg Magnesium											27 Al Aluminium	28 Si Silicon	31 P Phosphorus	32 S Sulfur	35.5 Cl Chlorine	40 Ar Argon							
39 K Potassium	40 Ca Calcium	45 Sc Scandium	48 Ti Titanium	51 V Vanadium	52 Cr Chromium	55 Mn Manganese	56 Fe Iron	59 Co Cobalt	59 Ni Nickel	64 Cu Copper	65 Zn Zinc	70 Ga Gallium	73 Ge Germanium	75 As Arsenic	79 Se Selenium	80 Br Bromine	84 Kr Krypton							
85 Rb Rubidium	88 Sr Strontium	89 Y Yttrium	91 Zr Zirconium	93 Nb Niobium	96 Mo Molybdenum	98 Tc Technetium	101 Ru Ruthenium	103 Rh Rhodium	106 Pd Palladium	108 Ag Silver	112 Cd Cadmium	115 In Indium	119 Sn Tin	122 Sb Antimony	128 Te Tellurium	127 I Iodine	131 Xe Xenon							
133 Cs Caesium	137 Ba Barium	139 La [*] Lanthanum	178 Hf Hafnium	181 Ta Tantalum	184 W Tungsten	186 Re Rhenium	190 Os Osmium	192 Ir Iridium	195 Pt Platinum	197 Au Gold	201 Hg Mercury	204 Tl Thallium	207 Pb Lead	209 Bi Bismuth	210 Po Polonium	210 At Astatine	222 Rn Radon							
223 Fr Francium	226 Ra Radium	227 Ac [†] Actinium	261 Rf Rutherfordium	262 Db Dubnium	266 Sg Seaborgium	264 Bh Bohrium	277 Hs Hassium	268 Mt Meitnerium	271 Ds Darmstadtium	272 Rg Roentgenium	285 Cn Copernicium													
			140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	145 Pm Promethium	150 Sm Samarium	152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium								
			232 Th Thorium	231 Pa Protactinium	238 U Uranium	237 Np Neptunium	242 Pu Plutonium	243 Am Americium	247 Cm Curium	245 Bk Berkelium	251 Cf Californium	254 Es Einsteinium	253 Fm Fermium	256 Md Mendelevium	254 No Nobelium	257 Lr Lawrencium								
			90	91	92	93	94	95	96	97	98	99	100	101	102	103								

a

X

b

a = relative atomic mass (approx)

x = atomic symbol

b = atomic number

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

$\begin{matrix} a \\ \boxed{X} \\ b \end{matrix}$ a = relative atomic mass (approx)
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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
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1.0–3.0	–NH	Amines
2.0–3.0	–CO–CH	Ketones
	–N–CH	Amines
	C ₆ H 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 ₆ H ₅	Arenes (on ring)
9.0–10.0	–CHO	Aldehydes
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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																	
Group																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen																	4 He Helium
7 Li Lithium	9 Be Beryllium											11 B Boron	12 C Carbon	14 N Nitrogen	16 O Oxygen	19 F Fluorine	20 Ne Neon
23 Na Sodium	24 Mg Magnesium											27 Al Aluminium	28 Si Silicon	31 P Phosphorus	32 S Sulfur	35.5 Cl Chlorine	40 Ar Argon
39 K Potassium	40 Ca Calcium	45 Sc Scandium	48 Ti Titanium	51 V Vanadium	52 Cr Chromium	55 Mn Manganese	56 Fe Iron	59 Co Cobalt	59 Ni Nickel	64 Cu Copper	65 Zn Zinc	70 Ga Gallium	73 Ge Germanium	75 As Arsenic	79 Se Selenium	80 Br Bromine	84 Kr Krypton
85 Rb Rubidium	88 Sr Strontium	89 Y Yttrium	91 Zr Zirconium	93 Nb Niobium	96 Mo Molybdenum	98 Tc Technetium	101 Ru Ruthenium	103 Rh Rhodium	106 Pd Palladium	108 Ag Silver	112 Cd Cadmium	115 In Indium	119 Sn Tin	122 Sb Antimony	128 Te Tellurium	127 I Iodine	131 Xe Xenon
133 Cs Caesium	137 Ba Barium	139 La [*] Lanthanum	178 Hf Hafnium	181 Ta Tantalum	184 W Tungsten	186 Re Rhenium	190 Os Osmium	192 Ir Iridium	195 Pt Platinum	197 Au Gold	201 Hg Mercury	204 Tl Thallium	207 Pb Lead	209 Bi Bismuth	210 Po Polonium	210 At Astatine	222 Rn Radon
223 Fr Francium	226 Ra Radium	227 Ac [†] Actinium	261 Rf Rutherfordium	262 Db Dubnium	266 Sg Seaborgium	264 Bh Bohrium	277 Hs Hassium	268 Mt Meitnerium	271 Ds Darmstadtium	272 Rg Roentgenium	285 Cn Copernicium						
			140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	145 Pm Promethium	150 Sm Samarium	152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium	
			232 Th Thorium	231 Pa Protactinium	238 U Uranium	237 Np Neptunium	242 Pu Plutonium	243 Am Americium	247 Cm Curium	245 Bk Berkelium	251 Cf Californium	254 Es Einsteinium	253 Fm Fermium	256 Md Mendelevium	254 No Nobelium	257 Lr Lawrencium	
			90	91	92	93	94	95	96	97	98	99	100	101	102	103	

a

X

b

a = relative atomic mass (approx)

x = atomic symbol

b = atomic number

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

$\begin{matrix} a \\ \boxed{X} \\ b \end{matrix}$ a = relative atomic mass (approx)
x = atomic symbol
b = atomic number