Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2025

Centre Number

Candidate Number

Chemistry

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

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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 $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

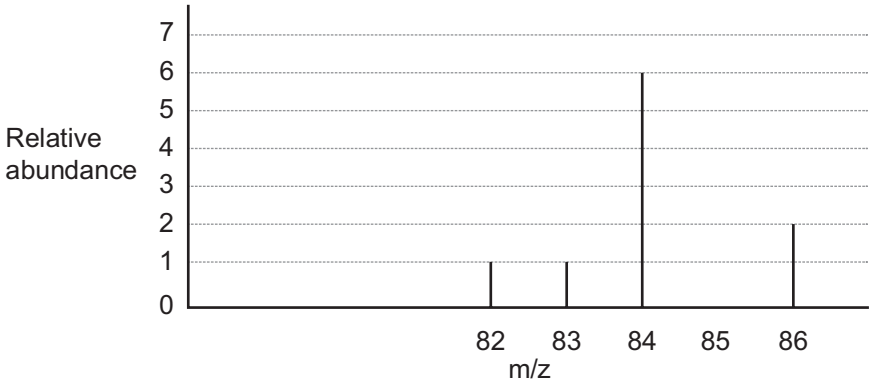
B $^{37}Cl^-$ has more protons than $^{35}Cl^-$

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

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

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?

$$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$$

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

Section B

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

11 **(a)** Complete the following table.

Name	Formula
sodium thiosulfate	
	$Ca_3(PO_4)_2$
potassium nitrite	
	$(NH_4)_2CrO_4$

[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.

_____ [2]

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

_____

_____

_____

_____ [3]

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

_____ [1]

(iv) Describe the test for oxygen gas.

_____

_____ [1]

[Turn over

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.

_____ [1]

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

_____

_____

_____

_____ [2]

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

_____

_____

_____

_____

_____ [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 (✗), 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			
iodine			

[1]

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

From _____ to _____ [1]

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

_____ [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.

_____

_____

_____

_____

_____ [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.

_____ [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.

_____ [1]

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

_____

_____

_____ [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.

_____

_____

_____ [1]

(f) The concentration of a solution of sodium bromide is 6.5 mg in 100 cm^3 of water. Calculate the molarity of the sodium bromide solution. Give your answer to 2 significant figures.

Answer _____ 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.

_____

_____ [1]

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

_____ [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.

[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^+

_____

_____

_____

_____

_____

_____

azanide ion, NH_2^-

_____

_____

_____

_____

_____

_____ [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.

_____ [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.

_____

_____

_____

_____

_____ [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.

_____

_____

_____

_____ [2]

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

sodium: _____

sulfur: _____ [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 ($Na_2S.xH_2O$) 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.

Answer _____ [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.

_____

_____ [1]

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

_____

_____ [1]

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

_____

_____

_____ [1]

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.

_____

_____

_____

_____

_____

_____

_____ [5]

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

_____ [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.

Answer _____ 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:

$$M_2CO_3 + 2HCl \rightarrow 2MCl + H_2O + CO_2$$

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

Indicator: _____

Explanation: _____

_____

Colour change at end point:

From _____ to _____ [3]

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

Answer _____ [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.

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER

DO NOT WRITE ON THIS PAGE

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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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}
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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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Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
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chemistry

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

$^{a}_{b}X$

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

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