Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2022

Centre Number

Candidate Number

Chemistry

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

SCH14

[SCH14]
TUESDAY 17 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.
Answer **all sixteen** questions in **Sections A and 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 in black ink only. **Do not write with a gel pen or a pencil.**

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.
Quality of written communication will be assessed in Question **13(a)(ii)**.
The 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, containing some data, is included with this question paper.

13028

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 and write the appropriate letter in the space provided.

1 Which one of the following does **not** obey the octet rule?

A NH_3

B BF_3

C OH^-

D N_2

Answer _____ [1]

2 The first six successive ionisation energies (in kJ mol^{-1}) of an element M are:

740 1500 7700 10500 13600 18000

The formula of the oxide of M is:

A MO

B MO_2

C M_2O

D M_2O_3

Answer _____ [1]

3 Which one of the following contains a co-ordinate bond?

A NH_2^-

B NH_3

C NH_4^+

D NH^{2-}

Answer _____ [1]

4 Bromine has two isotopes, ^{79}Br and ^{81}Br. A mass spectrum of bromine (Br_2) will only contain peaks at m/z values:

A 79 and 81

B 79, 81, 158 and 162

C 79, 81, 158, 160 and 162

D 158, 160 and 162

Answer _____ [1]

5 Which one of the following gives the correct numbers and shapes of orbitals occupied by electrons in an atom of neon?

A One spherical and one dumbbell

B One spherical and three dumbbell

C Two spherical and one dumbbell

D Two spherical and three dumbbell

Answer _____ [1]

[Turn over

6 Isotopes are atoms with:

A different atomic numbers and different mass numbers

B different atomic numbers and same mass number

C same atomic number and different mass numbers

D same atomic number and same mass number

Answer _____ [1]

7 The shape of the AlH_4^- ion is:

A bent

B pyramidal

C tetrahedral

D T-shaped

Answer _____ [1]

8 A white solid gives a crimson flame test and fizzes with dilute hydrochloric acid. The white solid is:

A calcium carbonate

B calcium nitrate

C lithium carbonate

D lithium nitrate

Answer _____ [1]

9 The melting points of the elements going across the third period rise to a peak and then:

A fall

B fall and rise again

C fall, rise and fall again

D fall, rise, fall and rise again

Answer _____ [1]

10 Which of the following does **not** have a giant structure?

A calcium

B diamond

C sodium chloride

D sulfur

Answer _____ [1]

Section B

Answer **all six** questions in this section

11 Copper(I) oxide is a red solid. It reacts with sulfuric acid in a disproportionation reaction forming copper, copper(II) sulfate and water.

(a) (i) State what is meant by a **disproportionation reaction**.

_____

_____ [2]

(ii) Write the equation for the disproportionation reaction.

_____ [1]

(b) Explain how you could test for the presence of copper(II) ions in the solution formed.

Experimental details are not required.

_____

_____ [2]

12 The halogens are Group VII in the Periodic Table.

(a) Compare the colour and relative solubility of iodine in water and hexane.

[3]

(b) The boiling points of the hydrogen halides are shown in the table below.

Hydrogen halide	HF	HCl	HBr	HI
Boiling point /°C	20	–85	–67	–35

Explain the change in boiling points of the hydrogen halides.

[4]

(c) Bromine is an important reagent in producing chemicals such as NaBrO and $NaBrO_3$.

(i) Give the systematic names of NaBrO and $NaBrO_3$.

NaBrO _____

$NaBrO_3$ _____ [2]

(ii) NaBrO and $NaBrO_3$ can be prepared by the reaction of bromine with sodium hydroxide solution. State the conditions and write the equations for the formation of NaBrO and $NaBrO_3$.

NaBrO

Conditions: _____

Equation: _____

$NaBrO_3$

Conditions: _____

Equation: _____ [6]

(iii) Describe the test to show the presence of bromide ions in solution.

_____

_____ [2]

(d) Both chlorine and ozone can be used in the treatment of drinking water.

(i) Give one advantage and one disadvantage of chlorine and ozone in treating drinking water.

chlorine

Advantage: _____

_____

Disadvantage: _____

_____

ozone

Advantage: _____

_____

Disadvantage: _____

_____ [4]

(ii) Describe the test to identify chlorine gas.

_____

_____ [2]

[Turn over

13 The table below shows the first ionisation energies and the electronegativity values of the elements in the second period.

Element	Li	Be	B	C	N	O	F	Ne
First ionisation energy /kJ mol^{-1}	520	900	800	1090	1400	1310	1680	2086
Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0	

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

[2]

(ii) State and explain the general trend in the first ionisation energy across the second period. Identify and explain any exceptions to this general trend.

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

[6]

(b) (i) State what is meant by **electronegativity**.

_____

_____

_____ [2]

(ii) Explain the change in electronegativity across the second period.

_____

_____

_____ [2]

[Turn over

(c) Fluorine forms an ionic compound with lithium, lithium fluoride (LiF), and a covalent compound with oxygen, oxygen difluoride (OF_2).

(i) Using electronegativity, explain why lithium fluoride is ionic.

_____

_____

_____ [1]

(ii) Draw a dot and cross diagram for a molecule of oxygen difluoride using outer electrons only.

[2]

(iii) Show the polarity of an oxygen–fluorine bond, using partial charges.

O—F

[1]

(iv) State the shape of the oxygen difluoride molecule.

_____ [1]

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(Questions continue overleaf)

14 Saline solution contains 0.90 g sodium chloride in 100 cm^3 of solution.

(a) The relative formula mass of sodium chloride is 58.5.

(i) State what is meant by **relative formula mass**.

_____

_____

_____ [2]

(ii) Calculate the molarity of saline solution. Give your answer to 2 significant figures.

_____

_____

_____ [2]

(b) Draw a dot and cross diagram, using outer electrons only, to show the formation of sodium chloride from a sodium atom and a chlorine atom.

[2]

(c) Concentrated sulfuric acid reacts with sodium chloride to form hydrogen chloride.

(i) Write the equation for the reaction of concentrated sulfuric acid with sodium chloride.

_____ [2]

(ii) Describe the chemical test for hydrogen chloride.

_____

_____

_____ [2]

[Turn over

15 (a) Thallium is a metallic element that exhibits typical metallic properties. It has a relatively high melting point and is a good electrical conductor.

(i) Explain why thallium has a relatively high melting point.

_____

_____

_____ [2]

(ii) Explain why thallium conducts electricity.

_____

_____

_____ [2]

(b) The electron configuration of thallium can be represented as $[Xe]\,4f^{14}\,5d^{10}\,6s^{2}\,6p^{1}$.

(i) Explain why thallium is described as a p-block element.

_____ [1]

(ii) State the period and group of the Periodic Table in which thallium is found.

period: _____

group: _____ [2]

(iii) Thallium forms the ions Tl^{+} and Tl^{3+}. Using the representation above, write the electron configuration of these ions.

Tl^{+}: [Xe] _____

Tl^{3+}: [Xe] _____ [2]

(c) Thallium(I) sulfate was used in rat poison. It was prepared by the reaction of thallium with sulfuric acid.

Write the equation for the reaction of thallium with sulfuric acid.

_____ [2]

(d) Thallium(III) oxide is a black solid which decomposes into thallium(I) oxide and oxygen at 800 °C according to the equation:

$$Tl_2O_3(s) \rightarrow Tl_2O(s) + O_2(g)$$

Calculate the loss in mass when 1.72 g of thallium(III) oxide are heated to constant mass. Give your answer to 3 significant figures.

_____

_____

_____

_____ [3]

16 Oxalic acid is a weak acid which can form a hydrated salt, $(COOH)_2.xH_2O$.

(a) Explain what is meant by the term **hydrated**.

_____

_____ [1]

(b) Explain what is meant by a **weak acid**.

_____

_____ [1]

(c) The value of x in $(COOH)_2.xH_2O$ may be found by titration with a standard solution of sodium hydroxide.

1.60 g of the hydrated oxalic acid were dissolved in 250 cm^3 of distilled water.
25.0 cm^3 of the solution were transferred to a conical flask.
A suitable indicator was added.
25.4 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution were needed for neutralisation.

The equation for the reaction is:

$$(COOH)_2 + 2NaOH \rightarrow (COONa)_2 + 2H_2O$$

(i) Suggest a suitable indicator and state the colour change at the endpoint.

Indicator: _____

From: _____ to _____ [3]

(ii) Calculate the mass of oxalic acid $(COOH)_2$ in the 250 cm^3 of solution.
Give your answer to two decimal places.

[3]

(iii) Calculate the value of x in the formula $(COOH)_2.xH_2O$.

[3]

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	
16	
Total Marks	

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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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

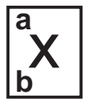
chemistry

THE PERIODIC TABLE OF ELEMENTS

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

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