Rewarding Learning

Centre Number

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[SCH12]

SCH12

TUESDAY 22 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 fourteen** 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 four** questions 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 in black ink only. **Do not write with a gel pen.**

INFORMATION FOR CANDIDATES

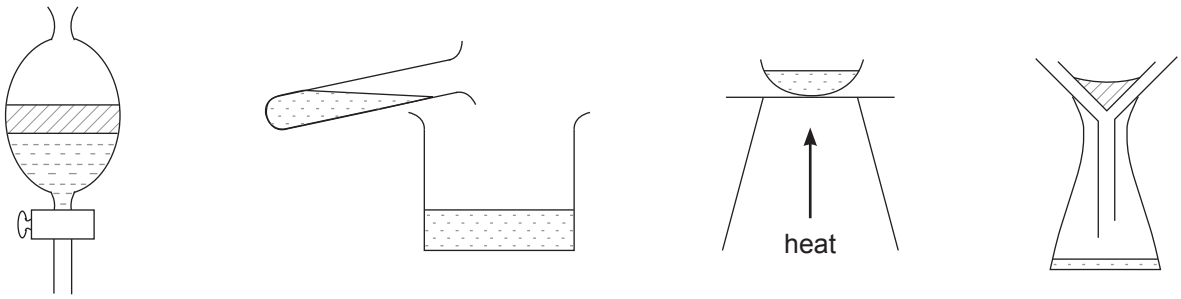
The total mark for this paper is 90.
Quality of written communication will be assessed in Question **13(a)**.
In Section A all questions carry equal marks, i.e. **one** mark for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements, containing some data, is included with this question paper.

Section A

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

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

1 A solution of barium chloride was added to sodium sulfate solution.



P Q R S

Which combination of methods should be used to obtain the precipitate and the other product as a solid?

A P + Q

B P + R

C Q + S

D R + S

2 Which species has the same electronic arrangement as a lithium ion, Li^+?

A Be^-

B B^{2+}

C H^+

D He

3 Sodium azide decomposes, in an airbag, to form sodium and nitrogen.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

The sodium then reacts with potassium nitrate to form more nitrogen gas.

$$10Na + 2KNO_3 \rightarrow 5Na_2O + N_2 + K_2O$$

0.50 mol of sodium azide produces

A 0.50 mol of nitrogen.

B 0.75 mol of nitrogen.

C 0.80 mol of nitrogen.

D 2.00 mol of nitrogen.

4 Chlorine has two isotopes. How many peaks are there in the mass spectrum of chlorine?

A 2

B 3

C 4

D 5

5 Which molecule is **not** planar?

A BF_3

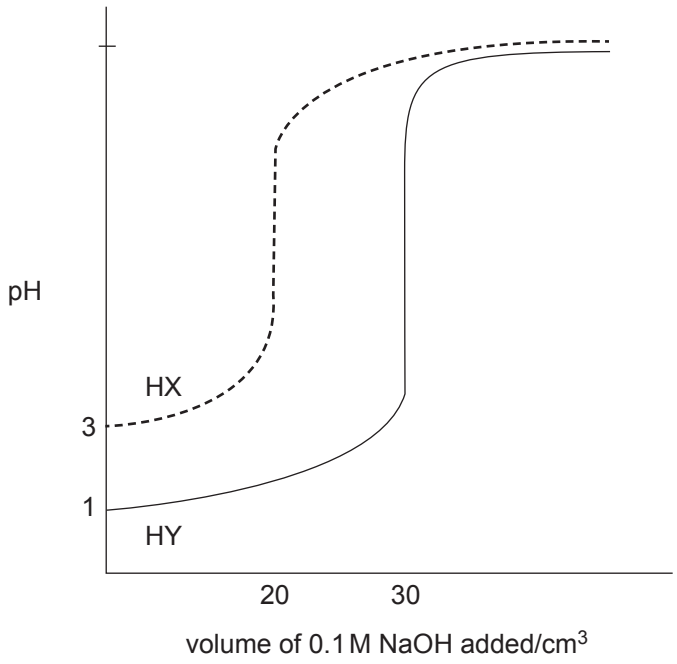
B $BeCl_2$

C HCHO

D NCl_3

[Turn over

6 The curves shown below are for 25 cm^3 of acids HX and HY when they are reacted with 0.1 M sodium hydroxide solution.



Compared to acid HY, the acid HX is

A more concentrated and stronger.

B more concentrated and weaker.

C less concentrated and stronger.

D less concentrated and weaker.

7 The largest mass of silver chloride precipitated is when excess silver ions are added to

A 25.0 cm^3 of 0.80 M hydrochloric acid.

B 30.0 cm^3 of 0.30 M iron(III) chloride solution.

C 50.0 cm^3 of 0.20 M magnesium chloride solution.

D 50.0 cm^3 of 0.50 M sodium chloride solution.

8 On melting, covalent bonds are broken in

A bromine.

B diamond.

C sodium chloride.

D sulfur(IV) oxide.

9 Which of the following equations represents a redox reaction?

A $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$

B $3Cl_2 + 6OH^- \rightarrow 5Cl^- + ClO_3^- + 3H_2O$

C $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$

D $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$

10 Which halide has the most covalent character?

A $AlBr_3$

B AlF_3

C $MgBr_2$

D MgF_2

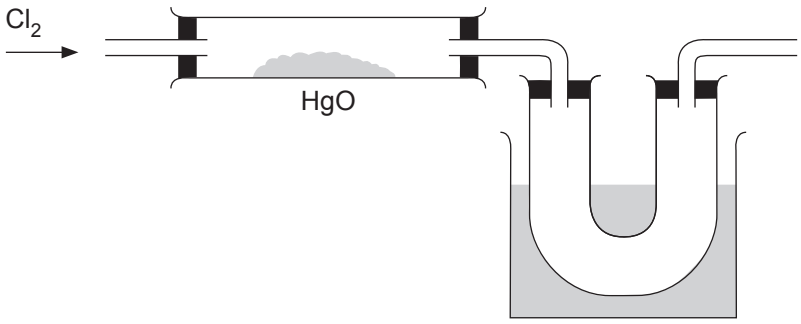
[Turn over

Section B

Answer **all four** questions in this section

11 Chlorine monoxide is a brown-yellow gas with a boiling point of 4 °C while chlorine has a boiling point of −34 °C. The monoxide is formed when excess chlorine is passed over mercury(II) oxide.

$$2Cl_2(g) + HgO(s) \rightarrow HgCl_2(s) + Cl_2O(g)$$



The escaping gases are passed through a U-tube which is cooled to −30 °C.
The chlorine monoxide condenses in the U-tube.

(a) (i) How could you test to show that chlorine is passing into the reaction tube?

_____

_____ [2]

(ii) What is the colour of chlorine?

_____ [1]

(iii) Why is it important to limit the temperature of the U-tube to −30 °C and not to have it lower than this temperature?

_____

_____ [1]

(iv) How could you show that it is a chloride which remains in the reaction tube?

_____

_____

_____ [3]

(v) Mercury(II) oxide decomposes when heated to form oxygen and mercury. How could you show that there was no mercury(II) oxide left in the reaction tube at the end of the experiment?

_____

_____

_____ [3]

(vi) Chlorine monoxide cannot be collected over water as it is very soluble in water, with a solubility of 143 g in 100 cm^3 at room temperature and pressure. Explain how you could show that chlorine monoxide is very soluble in water.

_____

_____

_____

_____

_____

_____ [4]

[Turn over

(b) Chlorine monoxide slowly reacts with water to form hypochlorous acid

$$Cl_2O + H_2O \rightarrow 2HOCl$$

(i) Hypochlorous acid has a systematic name based on chloric acid. State the systematic name for hypochlorous acid.

_____ [1]

(ii) Hypochlorous acid is a weak acid. Explain what is meant by the term **weak acid**.

_____

_____ [2]

(iii) Hypochlorous acid decomposes to give hydrochloric acid and oxygen. Write the equation for this reaction.

_____ [2]

(c) Chlorine monoxide obeys the octet rule.

(i) State the **octet rule**.

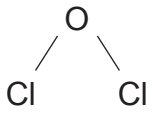
_____

_____ [2]

(ii) Draw the electronic structure of chlorine monoxide showing the outer electrons only.

[2]

(d) Chlorine monoxide has the following shape.



(i) Name the shape.

_____ [1]

(ii) How many lone pairs are there in a chlorine monoxide molecule?

_____ [1]

(iii) Explain why chlorine monoxide forms this shape.

_____

_____

_____ [2]

(e) Fluorine also forms an oxide but this oxide is known as oxygen fluoride because fluorine has a greater electronegativity than oxygen. State how electronegativity changes across a Period and down a Group.

_____

_____ [2]

(f) It has been suggested that chlorine monoxide is the active ingredient in the treatment of water for drinking purposes. Name **two** substances that are used to treat water for drinking.

_____

_____ [2]

[Turn over

12 Ammonium dichromate is used in the "volcano" experiment. When heated, it decomposes to produce a vast amount of green chromium oxide and gases which push out the green "ash" to form a pile of "lava".

$$(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2O$$

The water forms steam because of the heat of the reaction.

(a) Write the equation for the reaction, *with state symbols*, for the reactants and products.

_____ [1]

(b) Ammonium dichromate is very soluble in water. At room temperature 10.0 g of ammonium dichromate dissolve in 25.0 cm^3 of water. The orange solution can be tested for the presence of ammonium ions.

(i) Calculate the solubility of the ammonium dichromate in g dm^{-3} to 3 significant figures.

_____

_____ [1]

(ii) Calculate the solubility of the ammonium dichromate in mol dm^{-3} to 3 significant figures.

_____

_____ [1]

(iii) Explain how you would show that the orange solution contains ammonium ions.

_____

_____

_____ [3]

(c) The nitrogen given off in the reaction consists of two isotopes, nitrogen-14 and nitrogen-15. The percentage abundance of nitrogen-14 is 99.632%.

(i) Explain what is meant by the term **isotopes**.

_____

_____ [2]

(ii) Calculate the percentage abundance of nitrogen-15 given off.

_____

_____ [1]

(iii) Calculate the relative atomic mass of nitrogen to three decimal places.

_____

_____

_____

_____ [2]

(iv) Explain why there is a difference between the calculated relative atomic mass and the one provided in the data sheet.

_____

_____ [1]

.

[Turn over

(d) The dichromate ion is a very strong oxidising agent. The half-equation which shows its oxidising ability is:

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

(i) Use this equation to explain, in terms of oxidation numbers, why the dichromate ion is an oxidising agent.

[2]

(ii) Use this equation to explain, in terms of electrons, why the dichromate ion is an oxidising agent.

[1]

(e) Dichromates react with chlorides in the presence of concentrated sulfuric acid to produce chromyl chloride, CrO_2Cl_2, which is a deep red liquid with a boiling point of 117 °C. Using this information, explain whether chromyl chloride is ionic or covalent.

[2]

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(Questions continue overleaf)

[Turn over

13 **(a)** There are several types of structure which apply to chemical formulae. The species present may be atoms, molecules or ions. In each of the following examples describe which type of structure it is and which type of species is present.

sodium chloride

diamond

bromine

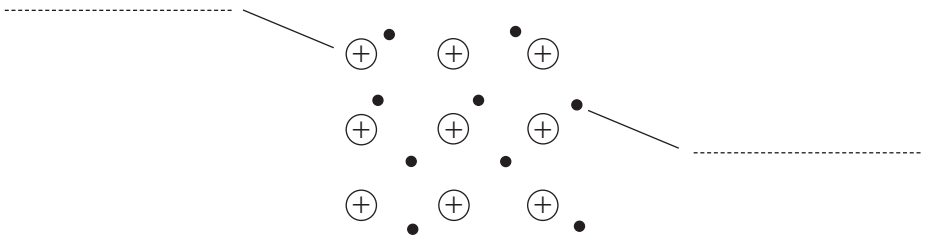
In this question you will be assessed on using your written communication skills including the use of specialist scientific terms.

[6]

(b) The different types of structure have different physical properties. State **four** physical properties that depend upon structure.

[3]

(c) The structure of sodium is shown below.



(i) Attach words to the labels shown. [2]

(ii) Use this diagram to explain whether magnesium has a greater or lower conductivity than sodium.

_____

_____

_____ [2]

(iii) Explain, using a labelled diagram, how you could compare the electrical conductivities of sodium and magnesium in the laboratory.

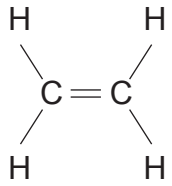
_____

_____

_____ [3]

[Turn over

14 Ethene is a gas at room temperature and has a boiling point of −104 °C at atmospheric pressure. It has a relative molecular mass of 28 which is approximately the same as the average relative molecular mass of air. It is a planar molecule which has the following structure:



(a) The ethene molecule contains single bonds and a double bond which are formed from s- and p-orbitals.

(i) Draw the shape of an s-orbital.

[1]

(ii) Draw the shape of a p-orbital.

[1]

(iii) Explain what is meant by the term **orbital**.

_____

_____ [2]

(b) Ethene is a non-polar molecule. There are two reasons why ethene can be considered to be non-polar. One is based on electronegativity and the other is based on shape.

(i) What is meant by the term **electronegativity**?

_____

_____ [2]

(ii) Explain why ethene is considered non-polar based on electronegativity.

_____

_____ [1]

(iii) Explain why ethene is considered non-polar based on shape.

_____

_____ [1]

(c) Ethene contains a double bond. Other molecules can contain triple bonds.

(i) Draw the structure of the hydrocarbon ethyne which contains two carbon atoms and a triple bond.

[1]

(ii) Name an element which contains a triple bond.

_____ [1]

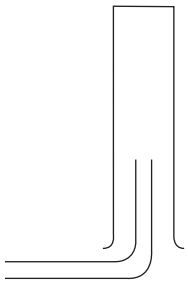
[Turn over

(d) When ethene burns, carbon dioxide and water are produced. Describe how you would carry out a test for carbon dioxide and the result expected for a positive test.

_____

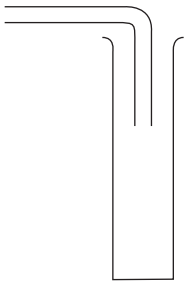
_____ [2]

(e) Gases can be collected by two different methods A or B depending on their relative molecular masses compared to air.



gas lighter than air

A



gas heavier than air

B

(i) Explain which method could be used to collect methane, CH_4.

_____

_____ [1]

(ii) Explain which method could be used to collect chlorine.

_____

_____ [1]

(f) The boiling point of methane is −161 °C. Explain why the boiling point of methane is lower than that of ethene.

_____

_____

_____ [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	
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

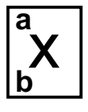
For first teaching from September 2016
For first award of AS Level in Summer 2017
For first award of A Level in Summer 2018
Subject Code: 1110

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