New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Centre Number

Candidate Number

Chemistry

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

[SCH12]

SCH12

FRIDAY 26 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 fifteen** 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 five** 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(c)**.
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.

10675

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 Bromine is formed in the reaction below.

$$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$$

Which statement about the reaction is correct?

A Bromide ions lose electrons

B Bromine is reduced by chlorine

C Chloride ions are reduced

D Chlorine is a weaker oxidising agent than bromide

2 Which trend in the Periodic Table is correct?

A Boiling point decreases from fluorine to bromine

B First ionisation energy decreases from lithium to caesium

C First ionisation energy increases from nitrogen to oxygen

D Melting point decreases from sodium to silicon

3 Which of the following is the structure of $^{55}Mn^{2+}$?

	protons	neutrons	electrons
A	25	30	23
B	25	30	27
C	27	30	25
D	30	25	28

4 Potassium iodide is formed when potassium is warmed in iodine vapour. Which of the following shows the bonding in the three species?

	potassium	**iodine**	**potassium iodide**
A	ionic	covalent	ionic
B	metallic	ionic	covalent
C	covalent	covalent	ionic
D	metallic	covalent	ionic

5 The element astatine lies below iodine in the Periodic Table and is likely to

A be black.

B be a volatile liquid at room temperature and pressure.

C form an astatide ion, At^{2-}.

D oxidise iodide ions to iodine.

6 Which molecule is non-polar?

A H_2S

B NH_3

C PF_3

D SF_6

7 The element boron has a relative atomic mass of 10.8. In this sample, boron exists as two isotopes, ^{10}B and ^{11}B. The percentage abundance of ^{10}B in this sample of boron is

A 10.8%.

B 20.0%.

C 80.0%.

D 89.2%.

8 When burned in oxygen magnesium forms magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

What is the number of molecules of oxygen required for the complete oxidation of 1.2 g of magnesium?

A 1.5×10^{22}

B 3.0×10^{22}

C 3.0×10^{23}

D 6.0×10^{23}

9 Which statement describes the trends in electronegativity values in the Periodic Table?

A Decrease across a Period and increase down a Group

B Decrease across a Period and decrease down a Group

C Increase across a Period and increase down a Group

D Increase across a Period and decrease down a Group

10 Which of the following would exactly neutralise 10.0 cm^3 of 1.00 mol dm^{-3} NaOH(aq)?

A 2.50 cm^3 of 1.00 mol dm^{-3} CH_3COOH

B 5.00 cm^3 of 1.00 mol dm^{-3} HCl

C 5.00 cm^3 of 1.00 mol dm^{-3} H_2SO_4

D 3.00 cm^3 of 1.00 mol dm^{-3} H_3PO_4

Section B

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

11 Sulfate, hydrogensulfate and thiosulfate ions are formed when sulfuric and thiosulfuric acids ionise.

(a) **(i)** Write the equation for the complete ionisation of thiosulfuric acid.

____ [2]

(ii) Write the formula for the hydrogensulfate ion.

____ [1]

(b) **(i)** Write the formula for ammonium sulfate.

____ [1]

(ii) Describe the bonding in ammonium sulfate.

____

____

____ [2]

(c) Describe how you could use chemical tests on an aqueous solution of ammonium sulfate to prove that it contains ammonium ions and sulfate ions.

____

____

____

____

____ [4]

12 Some properties of the metals sodium and aluminium are shown in the table below.

metal	charge on metal ion	electronic structure of the atom	melting point /°C
sodium	1+	$1s^2\ 2s^2\ 2p^6\ 3s^1$	98
aluminium	3+	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$	660

(a) Describe, without using a diagram, the bonding in sodium metal.

____

____

____ [2]

(b) Explain why aluminium has a higher melting point than sodium.

____

____

____ [2]

(c) (i) Write the equation, including state symbols, for the first ionisation energy of sodium.

____ [2]

(ii) The first six ionisation energies, in $kJ\,mol^{-1}$, of sodium are 496, 4563, 6913, 9544, 13352 and 16611. Explain which of these values can be used to identify sodium as belonging to Group I of the Periodic Table.

____

____

____ [2]

[Turn over

(iii) The outer electron in the sodium atom is located in the 3s orbital. Explain what is meant by the term **orbital**.

____

____ [2]

(d) Aluminium forms covalent bonds with chlorine.

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

____

____

____ [2]

(ii) Write the equation for the reaction of aluminium with chlorine to form aluminium chloride, $AlCl_3$.

____ [1]

(iii) State the octet rule and explain whether the atoms in aluminium chloride obey the rule.

____

____

____ [3]

13 (a) Zinc reacts with chlorine to form the ionic compound zinc chloride. Draw a dot and cross diagram, using outer electrons only, to show how zinc chloride, $ZnCl_2$, is formed from zinc and chlorine atoms.

[2]

(b) Zinc is an essential trace element. People who have a zinc deficiency can take hydrated zinc sulfate, $ZnSO_4.xH_2O$, as a dietary supplement.

The value of x can be determined by heating hydrated zinc sulfate to constant mass.

A student heated 5.65 g of hydrated zinc sulfate and obtained 3.85 g of anhydrous zinc sulfate.

(i) Calculate the number of moles of anhydrous zinc sulfate obtained.

______________________________ [1]

(ii) Calculate the mass of water present in the hydrated zinc sulfate.

______________________________ [1]

(iii) Calculate the number of moles of water present in the hydrated zinc sulfate.

______________________________ [1]

(iv) Calculate the value of x in $ZnSO_4.xH_2O$

______________________________ [1]

[Turn over

(c) Describe how you would prepare 250.0 cm^3 of a 28.7 g dm^{-3} zinc sulfate solution from the anhydrous solid.

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

[6]

14 Nitrogen and phosphorus are Group V elements. They form the toxic hydrides ammonia and phosphine.

(a) Ammonia is formed by the reversible reaction of nitrogen with hydrogen. Write the equation for this reaction.

____ [2]

(b) Phosphine is formed by the reaction of phosphorus with aqueous sodium hydroxide.

(i) Balance the equation for the formation of phosphine.

$$P_4 + NaOH + H_2O \rightarrow NaH_2PO_2 + PH_3$$

[1]

(ii) Deduce the oxidation number of phosphorus in:

P_4 ______________________

NaH_2PO_2 ______________________

PH_3 ______________________ [3]

(iii) Explain, using the oxidation numbers of phosphorus, why the reaction is described as disproportionation.

____

____

____

____ [3]

(c) The boiling point of ammonia is –33 °C while that of phosphine is –88 °C. Explain why the boiling point of ammonia is higher than that of phosphine.

____

____

____ [3]

(d) Both ammonia and phosphine molecules react with H^+ ions.

$$PH_3 + H^+ \rightarrow PH_4^+$$

(i) Name the type of bond formed between a phosphine molecule and the H^+ ion.

____ [1]

(ii) Draw and name the shapes of the molecule PH_3 and the ion PH_4^+.

PH_3

Shape ____________________

PH_4^+

Shape ____________________

[4]

(iii) Explain why the bond angle in PH_3 is different from the bond angle in PH_4^+.

____

____

____ [3]

(e) Ammonia is very soluble in water. Draw diagrams to show the two ways in which a molecule of ammonia can be attracted to a molecule of water. Include all partial charges and lone pairs in your diagram.

[4]

15 Ammonia is used to make nitric acid by the Ostwald Process outlined below.

Reaction 1: $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

Reaction 2: $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

Reaction 3: $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$

(a) (i) Calculate the number of moles of oxygen needed to react with 6.8 kg of ammonia.

____

____

____ [3]

(ii) Calculate the number of moles of nitrogen(IV) oxide which can be obtained from 6.8 kg of ammonia.

____

____ [2]

(iii) Calculate the concentration of nitric acid, in g dm^{-3}, produced on reacting the nitrogen(IV) oxide obtained in part **(ii)** with 50 dm^3 of water.

____

____

____ [3]

(b) Ammonia reacts with nitric acid according to the equation below.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

The following results were obtained by diluting 25.0 cm^3 of a concentrated ammonia solution to 250.0 cm^3 in a volumetric flask and then titrating 25.0 cm^3 portions of the diluted ammonia solution using 0.100 mol dm^{-3} nitric acid.

titration	initial burette reading /cm^3	final burette reading /cm^3	titre /cm^3
rough	0.00	22.00	22.00
first accurate	0.10	21.40	21.30
second accurate	0.20	21.60	21.40

(i) Name a suitable indicator for the titration and state the colour change at the end point.

____

____ [3]

(ii) Calculate the mean titre.

____

____ [1]

(iii) A burette has an uncertainty of $\pm 0.05\ cm^3$. Calculate the uncertainty when two burette readings are used to calculate a titre value.

____

____ [1]

(iv) Calculate the concentration of the concentrated ammonia solution in mol dm^{-3}.

____

____

____

____

____

____

____ [5]

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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	

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	$-C_6\mathbf{H}_5$	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.

New Specification

Rewarding Learning

GCE

CHEMISTRY DATA SHEET

GCE A/AS EXAMINATIONS

CHEMISTRY

Including the Periodic Table of the Elements

For the use of candidates taking
Advanced Subsidiary and Advanced Level
Chemistry 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.

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

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
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

Key: a / b x

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