

New  
Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2017

Centre Number

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Candidate Number

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# 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.

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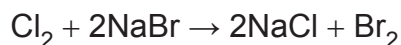
\*20SCH1201\*

**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.



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  $^{55}\text{Mn}^{2+}$  ?

	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,  $\text{At}^{2-}$ .  
 D oxidise iodide ions to iodine.

- 6 Which molecule is non-polar?

- A  $\text{H}_2\text{S}$   
 B  $\text{NH}_3$   
 C  $\text{PF}_3$   
 D  $\text{SF}_6$

[Turn over

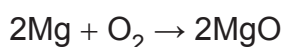
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7 The element boron has a relative atomic mass of 10.8. In this sample, boron exists as two isotopes,  $^{10}\text{B}$  and  $^{11}\text{B}$ . The percentage abundance of  $^{10}\text{B}$  in this sample of boron is

- A 10.8%.
- B 20.0%.
- C 80.0%.
- D 89.2%.

8 When burned in oxygen magnesium forms magnesium oxide.



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

- A  $1.5 \times 10^{22}$
  - B  $3.0 \times 10^{22}$
  - C  $3.0 \times 10^{23}$
  - D  $6.0 \times 10^{23}$
- 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<sup>3</sup> of 1.00 mol dm<sup>-3</sup> NaOH(aq)?

- A 2.50 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> CH<sub>3</sub>COOH
- B 5.00 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> HCl
- C 5.00 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> H<sub>2</sub>SO<sub>4</sub>
- D 3.00 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> H<sub>3</sub>PO<sub>4</sub>

[Turn over

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**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.

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[2]

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

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[2]

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

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[2]

(ii) The first six ionisation energies, in  $\text{kJ mol}^{-1}$ , 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.

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[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,  $\text{AlCl}_3$ .

\_\_\_\_\_ [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,  $\text{ZnCl}_2$ , 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,  $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$ , 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  $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$

[1]

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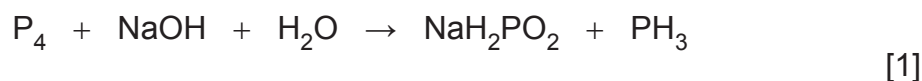
**14** Nitrogen and phosphorus are Group V elements. They form the toxic hydrides ammonia and phosphine.

- (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.



- (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]

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\*20SCH1211\*

- (c) The boiling point of ammonia is  $-33\text{ }^{\circ}\text{C}$  while that of phosphine is  $-88\text{ }^{\circ}\text{C}$ . Explain why the boiling point of ammonia is higher than that of phosphine.

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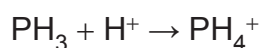
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[3]

- (d) Both ammonia and phosphine molecules react with  $\text{H}^+$  ions.



- (i) Name the type of bond formed between a phosphine molecule and the  $\text{H}^+$  ion.

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[1]

- (ii) Draw and name the shapes of the molecule  $\text{PH}_3$  and the ion  $\text{PH}_4^+$ .



Shape \_\_\_\_\_



Shape \_\_\_\_\_

[4]

- (iii) Explain why the bond angle in  $\text{PH}_3$  is different from the bond angle in  $\text{PH}_4^+$ .

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[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.

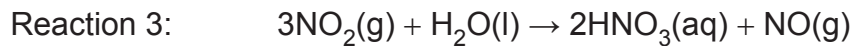
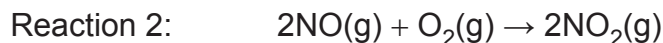
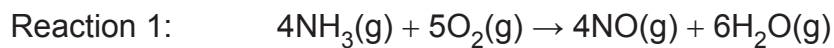
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15 Ammonia is used to make nitric acid by the Ostwald Process outlined below.



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

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[3]

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

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[2]

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

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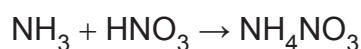
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[3]



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



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

titration	initial burette reading /cm <sup>3</sup>	final burette reading /cm <sup>3</sup>	titre /cm <sup>3</sup>
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]

[Turn over

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\*20SCH1215\*

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

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[1]

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

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[5]







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

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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<sup>3</sup>

Avogadro Constant =  $6.02 \times 10^{23}$  mol<sup>-1</sup>

Planck Constant =  $6.63 \times 10^{-34}$  J s

Specific Heat Capacity of water =  $4.2$  J g<sup>-1</sup> K<sup>-1</sup>

Speed of Light =  $3 \times 10^8$  m s<sup>-1</sup>

## Characteristic absorptions in IR spectroscopy

Wavenumber/cm <sup>-1</sup>	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	Compound
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 <sub>6</sub> H <sub>5</sub> –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 <sub>6</sub> H <sub>5</sub>	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.

New  
Specification

# 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 <b>H</b> Hydrogen 1																	4 <b>He</b> Helium 2
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12											27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	98 <b>Tc</b> Technetium 43	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> <sup>*</sup> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	222 <b>Rn</b> Radon 86
223 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	227 <b>Ac</b> <sup>†</sup> Actinium 89	261 <b>Rf</b> Rutherfordium 104	262 <b>Db</b> Dubnium 105	266 <b>Sg</b> Seaborgium 106	264 <b>Bh</b> Bohrium 107	277 <b>Hs</b> Hassium 108	268 <b>Mt</b> Meitnerium 109	271 <b>Ds</b> Darmstadtium 110	272 <b>Rg</b> Roentgenium 111	285 <b>Cn</b> Copernicium 112						

\* 58–71 Lanthanum series

† 90–103 Actinium series

a	x
b	

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

140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	145 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71
232 <b>Th</b> Thorium 90	231 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	237 <b>Np</b> Neptunium 93	242 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	247 <b>Cm</b> Curium 96	245 <b>Bk</b> Berkelium 97	251 <b>Cf</b> Californium 98	254 <b>Es</b> Einsteinium 99	253 <b>Fm</b> Fermium 100	256 <b>Md</b> Mendelevium 101	254 <b>No</b> Nobelium 102	257 <b>Lr</b> Lawrencium 103