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

MV18

[AC112]

FRIDAY 26 MAY, MORNING

Time

1 hour 30 minutes, plus your additional time allowance.

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.**
Complete in black ink only.

Information for Candidates

The total mark for this paper is 100.
Quality of written communication will be assessed in Question **11(d)(ii)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
A Periodic Table of Elements, containing some data, is included in 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 Which one of the following compounds contains the greatest number of ions in 1 kg?

A $NaCl$

B Na_2O

C $MgCl_2$

D MgO

2 The atomic radius of elements

A decreases down a group and decreases across a period.

B decreases down a group and increases across a period.

C increases down a group and decreases across a period.

D increases down a group and increases across a period.

3 The table below gives successive ionisation energies for the elements X and Y.

electron removed	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
X / kJ mol^{-1}	577	1820	2740	11600	14800	18400	23400	27500
Y / kJ mol^{-1}	1680	3370	6040	8410	11000	15100	17900	91600

Which one of the following is the formula of the compound formed between X and Y?

A XY_2

B XY_3

C X_2Y

D X_3Y

4 Which one of the following molecules is **not** polar?

A Ammonia

B Hydrogen fluoride

C Hydrogen sulfide

D Methane

5 Some relative isotopic masses are given in the table below.

isotope	^{1}H	^{2}H	^{12}C	^{14}N	^{16}O
relative isotopic mass	1.0078	2.0141	12.0000	14.0031	15.9949

Which one of the following can have a relative mass of 19.0168?

A CH_4

B H_2O

C NH_3

D NH_4^+

6 The intermolecular forces present in liquid ammonia are

A hydrogen bonds.

B hydrogen bonds and van der Waals forces.

C permanent dipole attractions.

D van der Waals forces.

7 A white solid gives a green colour in a flame test. A solution of the solid gives a cream precipitate when silver nitrate solution is added. Which one of the following is the white solid?

A Barium bromide

B Barium chloride

C Copper(II) bromide

D Copper(II) chloride

8 The thermite reaction is as follows:

$$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$$

What is the maximum mass of iron formed from 1 kg of iron(III) oxide and 0.5 kg of aluminium?

A 0.35 kg

B 0.52 kg

C 0.70 kg

D 1.04 kg

9 The melting points of the elements in the third period are shown in the table below.

Which one of the elements is silicon?

element	A			B	C			D
melting point / °C	–189	–101	44	98	113	650	660	1410

10 Which one of the following does **not** have the same number of electrons as a sodium ion, Na^+?

A NH_3

B NH_4^+

C NH_2^-

D NH_2^+

Section B

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

11 Calcium is found in Group II of the Periodic Table.

(a) Explain which block of the Periodic Table contains calcium. [2 marks]

_____

_____

(b) (i) Write the electronic configuration of a calcium atom. [1 mark]

_____

(ii) Draw the shapes of an s and a p orbital. [2 marks]

(c) The relative atomic mass of calcium can be calculated from the abundance of its isotopes.

(i) Explain what is meant by the term **relative atomic mass**. [2 marks]

_____

_____

_____

(ii) Use the information in the table below to calculate the relative atomic mass of calcium to two decimal places. [2 marks]

isotope	^{40}Ca	^{42}Ca	^{43}Ca	^{44}Ca	^{48}Ca
relative abundance (%)	96.94	0.65	0.13	2.09	0.19

(d) Calcium compounds can be identified by their flame colour.

(i) What is the flame colour of the calcium ion? [1 mark]

_____

(ii) Explain how the flame colour of the calcium ion arises. [3 marks]

Quality of written communication [2 marks]

12 Lithium is the first metallic element in the Periodic Table.

(a) (i) Draw a labelled diagram to show the bonding present in lithium metal. [3 marks]

(ii) Explain why lithium can conduct electricity. [2 marks]

_____

_____

(iii) Explain why magnesium is a better conductor of electricity than lithium. [1 mark]

_____

_____

(b) Lithium reacts with oxygen to form lithium oxide.

(i) Draw a dot and cross diagram for the formation of lithium oxide from lithium and oxygen atoms showing outer electrons only. [3 marks]

(ii) State **two** physical properties you would expect lithium oxide to have. [2 marks]

_____

_____

(c) Graphite, a non-metal, is an electrical conductor whereas diamond is not.

(i) Explain why the structure of graphite allows it to conduct electricity. [1 mark]

_____

_____

(ii) Explain why the structure of diamond prevents it from conducting electricity. [1 mark]

_____

_____

13 Barium carbonate, $BaCO_3$, is found in the mineral Witherite. The percentage of barium carbonate in a sample of Witherite can be found by back titration. The Witherite is reacted with an excess of hydrochloric acid.

$$BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$$

The excess hydrochloric acid is titrated with standard sodium hydroxide solution.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

(a) Explain what is meant by the term **standard solution**. [1 mark]

_____

_____

(b) Suggest a suitable indicator for the titration and state the colour change at the end point. [3 marks]

Indicator: _____

Colour change: from _____ to _____

(c) 20.0 cm^3 of 2.0 mol dm^{-3} hydrochloric acid were added to 1.85 g of Witherite. The solution formed was made up to 250 cm^3 in a volumetric flask. A 25.0 cm^3 portion of this solution required 22.4 cm^3 of 0.1 mol dm^{-3} sodium hydroxide solution for complete reaction.

How many moles of hydrochloric acid were added to the Witherite?

_____

How many moles of sodium hydroxide reacted with the 25.0 cm^3 portion of solution?

_____

How many moles of hydrochloric acid were in the 25.0 cm^3 portion?

_____

How many moles of hydrochloric acid were in 250 cm^3 of the solution?

_____

How many moles of hydrochloric acid reacted with the Witherite?

_____

How many moles of barium carbonate were present in the sample of Witherite?

What mass of barium carbonate was present in the Witherite?

What is the percentage mass of barium carbonate in the sample of Witherite? [6 marks]

(d) What assumption about impurities in the Witherite has been made in the back titration? [1 mark]

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14 The table below gives some information about the halogens.

	fluorine	**chlorine**	**bromine**	**iodine**
appearance at room temperature	yellow gas			
boiling point/°C	–188	–34	59	sublimes*
first ionisation energy/ kJ mol^{-1}	1680	1251	1140	1008

*changes directly from solid to gas

(a) (i) Complete the table by describing the appearance of each halogen. [3 marks]

(ii) Explain the change in the boiling points of the halogens. [2 marks]

(iii) Explain the change in the first ionisation energies of the halogens. [2 marks]

(b) Iodine undergoes different reactions with solutions of cold dilute hydroxide ions and hot concentrated hydroxide ions.

(i) Write the ionic equation for the reaction of cold dilute hydroxide ions with iodine to give iodate(I) ions. [2 marks]

(ii) Write the ionic equation for the reaction of hot concentrated hydroxide ions with iodine to give iodate(V) ions. [2 marks]

(c) Iodide ions react with iodate ions as follows:

$$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$$

Using oxidation numbers explain why this is described as a redox reaction. [3 marks]

(d) Iron(III) ions are reduced to iron(II) ions by iodide ions.

(i) Write an ionic equation for the reaction. [1 mark]

(ii) State the colour change which is observed in the reaction. [2 marks]

(e) Solid potassium iodide reacts with concentrated sulfuric acid to produce a variety of products. Give **three** observations which could be made during the reaction. [3 marks]

(f) Some public water supplies are fluoridated.

(i) Explain what is meant by the term **fluoridation**. [1 mark]

(ii) Give **one** advantage and **one** disadvantage of fluoridation. [2 marks]

Advantage: _____

_____

Disadvantage: _____

_____

15 The name flerovium, symbol Fl, was assigned to element 114 in 2012.

(a) Flerovium has three isotopes.

(i) Explain what is meant by the term **isotopes**. [1 mark]

(ii) Complete the table below showing the number of protons, neutrons and electrons present in each isotope of flerovium. [2 marks]

	^{287}Fl	^{289}Fl	^{292}Fl
protons			
neutrons			
electrons			

(iii) Explain why there is no difference in the chemical properties of the isotopes of flerovium. [1 mark]

(b) The table below shows the number of electrons in each of flerovium's shells.

electron shell	**1**	**2**	**3**	**4**	**5**	**6**	**7**
number of electrons	2	8	18	32	32	18	4

(i) Suggest in which period of the Periodic Table flerovium is found. [1 mark]

_____

(ii) Suggest in which group of the Periodic Table flerovium is found. [1 mark]

_____

(c) Flerovium forms a number of compounds and ions, including FlF_4, FlH_4, FlO_2^{2-} and FlF_6^{2-}.

(i) Write an equation for the formation of FlF_4 from its elements. [1 mark]

_____

(ii) FlH_4 is unstable and decomposes to form FlH_2. Write an equation for the decomposition. [1 mark]

_____

(iii) FIO_2^{2-} is formed when FIO reacts with water. Write an equation for the reaction. [1 mark]

_____

(iv) Draw dot and cross diagrams, using only the outer electrons, for FIF_4 and FIF_6^{2-}. [2 marks]

(v) Suggest the shapes of the FIF_4 molecule and the FIF_6^{2-} ion. [2 marks]

FIF_4 _____

FIF_6^{2-} _____

(d) The first ionisation energy of flerovium is 823.9 kJ mol^{-1}.

(i) Write an equation for the first ionisation of flerovium. [2 marks]

(ii) Calculate the frequency of the light associated with the value of the first ionisation energy of flerovium. [3 marks]

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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	

Examiner Number

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Periodic Table of the Elements

For the use of candidates taking

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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.

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THE PERIODIC TABLE OF ELEMENTS

I	II										III	IV	V	VI	VII	0
						Group										
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	99 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														

One mole of any gas at 20 °C and a pressure of 1 atmosphere (10^5 Pa) occupies a volume of 24 dm^3.

Planck Constant = 6.63×10^{-34} Js

Gas Constant = 8.31 J mol^{-1} K^{-1}

Avogadro Constant = 6.02×10^{23} mol^{-1}

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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 / b x

a = relative atomic mass (approx.)

x = atomic symbol

b = atomic number