Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9629032111

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **October/November 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 10 and 11.
A Periodic Table is printed on page 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
3	
Total	

This document consists of **12** printed pages.

CAMBRIDGE International Examinations

1 In this experiment you will determine the relative atomic mass, A_r, of magnesium by a titration method.

FB 1 is 2.00 mol dm^{-3} hydrochloric acid, HC*l*.
FB 3 is 0.120 mol dm^{-3} sodium hydroxide, NaOH.
magnesium ribbon
bromophenol blue indicator

(a) Method

Reaction of magnesium with FB 1

- Pipette 25.0 cm^3 of **FB 1** into the 250 cm^3 beaker.
- Weigh the strip of magnesium ribbon and record its mass.

mass of magnesium = ... g

- Coil the strip of magnesium ribbon loosely and then add it to the **FB 1** in the beaker.
- Stir the mixture occasionally and wait until the reaction has finished.

Dilution of the excess acid

- Transfer all the solution from the beaker into the volumetric flask.
- Make the solution up to the mark using distilled water.
- Shake the flask to mix the solution before using it for your titrations.
- Label this solution of hydrochloric acid **FB 2**.

Titration

- Fill the burette with **FB 2**.
- Rinse the pipette out thoroughly. Then pipette 25.0 cm^3 of **FB 3** into a conical flask.
- Add several drops of bromophenol blue indicator.
- Perform a rough titration, by running the solution from the burette into the conical flask until the mixture just becomes yellow.
- Record your burette readings in the space below.

The rough titre is ..... cm^3.

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make sure any recorded results show the precision of your practical work.
- Record in a suitable form below all of your burette readings and the volume of **FB 2** added in each accurate titration.

I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, obtain a suitable value for the volume of **FB 2** to be used in your calculations.
Show clearly how you have obtained this value.

25.0 cm^3 of **FB 3** required ..... cm^3 of **FB 2**. [1]

(c) Calculations

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

(i) Calculate the number of moles of sodium hydroxide present in 25.0 cm^3 of solution **FB 3**.

moles of NaOH = ... mol

(ii) Give the equation for the reaction of hydrochloric acid, HC*l*, with sodium hydroxide, NaOH. State symbols are **not** required.

.....

Deduce the number of moles of hydrochloric acid in the volume of **FB 2** you calculated in **(b)**.

moles of HC*l* = ... mol

(iii) Calculate the number of moles of hydrochloric acid in 250 cm^3 of **FB 2**.

moles of HC*l* in 250 cm^3 of **FB 2** = ... mol

(iv) Calculate the number of moles of hydrochloric acid in 25.0 cm^3 of **FB 1**.

moles of HC*l* in 25.0 cm^3 of **FB 1** = ... mol

(v) In **(a)**, you reacted 25.0 cm^3 of **FB 1** with your weighed piece of magnesium. After the reaction, the unreacted hydrochloric acid was used to prepare 250 cm^3 of **FB 2**.

Use your answers to **(iii)** and **(iv)** to calculate the number of moles of hydrochloric acid that reacted with the magnesium ribbon.

moles of HC*l* reacting with Mg = ... mol

(vi) Complete the equation below, for the reaction of magnesium with hydrochloric acid.
State symbols **are** required.

$$Mg + HCl \rightarrow MgCl_2 + ...$$

Use your answer to **(v)** to calculate the number of moles of magnesium used.

moles of Mg = ... mol

(vii) Use your answer to **(vi)** to calculate the relative atomic mass, A_r, of magnesium.

A_r of Mg = ...
[6]

(d) (i) State **one** observation that proves that the hydrochloric acid in **FB 1** was in excess for the reaction with the magnesium ribbon.

.....

.....

(ii) A student carried out exactly the same experiment but used 1.00 g of magnesium ribbon.
State and explain why the student's experiment could not be used to determine the value for the A_r of magnesium.
Include a calculation in your answer.

.....

.....
[3]

[Total: 17]

2 In this experiment you will determine the relative atomic mass of magnesium by thermal decomposition of hydrated magnesium sulfate.

$$MgSO_4.7H_2O(s) \rightarrow MgSO_4(s) + 7H_2O(g)$$

FB 4 is hydrated magnesium sulfate, $MgSO_4.7H_2O$.

(a) Method

Record all your weighings in the space below.

- Weigh the crucible with its lid.
- Transfer all **FB 4** into the crucible.
- Weigh the crucible, lid and **FB 4**.
- Place the crucible on the pipe-clay triangle.
- Heat the crucible gently with the lid **on**, for about one minute.
- Then heat the crucible strongly, without the lid, for a further four minutes.
- Leave the crucible and its contents to cool with the lid on, for several minutes.
- **While the crucible is cooling, begin work on Question 3.**
- When the crucible has cooled, weigh it, with the lid and contents.
- Calculate and record the mass of anhydrous magnesium sulfate produced and the mass of water lost.

I	
II	
III	

[3]

(b) Calculations

(i) Calculate the number of moles of water lost during heating.
(Use the data in the Periodic Table on page 12.)

moles of H_2O = ... mol

(ii) Use the **equation above** and **your answer to (i)** to calculate the number of moles of anhydrous magnesium sulfate produced.

moles of $MgSO_4$ = ... mol

(iii) Use your weighings and your answer to **(ii)** to calculate the relative formula mass, M_r, of anhydrous magnesium sulfate.

M_r of $MgSO_4$ = ...

(iv) From your answer to **(iii)**, calculate the relative atomic mass, A_r, of magnesium.

A_r of Mg = ...
[4]

(c) (i) How could the experiment be improved to ensure that the magnesium sulfate had been completely dehydrated?

.....

.....

(ii) Why is the lid put on the crucible during cooling?

.....

.....
[2]

[Total: 9]

3 Qualitative Analysis

At each stage of any test you are to record details of the following.

- colour changes seen
- the formation of any precipitate
- the solubility of such precipitates in an excess of the reagent added

Where gases are released they should be identified by a test, **described in the appropriate place in your observations**.

You should indicate clearly at what stage in a test a change occurs.
Marks are **not** given for chemical equations.
No additional tests for ions present should be attempted.

If any solution is warmed, a boiling tube MUST be used.

Rinse and reuse test-tubes and boiling tubes where possible.

Where reagents are selected for use in a test, the name or correct formula of the element or compound must be given.

(a) **FB 5** is a solution containing one cation and one anion.
Carry out test-tube tests to find out whether the cation in **FB 5** is magnesium and whether the anion is sulfate.

- State what reagents you used.
- Record the observations you made in a table.
- State your conclusions about which ions are present.

[4]

(b) **FB 6** is a salt containing one cation and one anion from those listed on pages 10 and 11.

(i) Place a **few** crystals of **FB 6** in a hard-glass test-tube.
Heat gently at first and then strongly.
Leave the test-tube and its contents to cool.

Record **all** your observations below.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Dissolve the remainder of **FB 6** in about 20 cm^3 of distilled water in a boiling tube for use in the following tests.

test	*observations*
To a 1 cm depth of the solution of **FB 6** in a test-tube, add a few drops of aqueous silver nitrate.	
To a 1 cm depth of the solution of **FB 6** in a test-tube, add a few drops of dilute sulfuric acid.	
To a 1 cm depth of the solution of **FB 6** in a test-tube, add aqueous ammonia.	

test	*observations*
To a 1 cm depth of the solution of **FB 6** in a boiling tube, add aqueous sodium hydroxide until in excess, then	
heat the mixture gently and carefully, and test any gas produced, then	
add a small piece of aluminium foil while the mixture is still warm. Test any gas produced.	

(iii) Deduce the formula of the salt in **FB 6**.

Formula is .....

[10]

[Total: 14]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

ion	*reaction with*	
	NaOH(aq)	NH_3(aq)
aluminium, Al^{3+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH_4^+(aq)	no ppt. ammonia produced on heating	–
barium, Ba^{2+}(aq)	no ppt. (if reagents are pure)	no ppt.
calcium, Ca^{2+}(aq)	white ppt. with high [Ca^{2+}(aq)]	no ppt.
chromium(III), Cr^{3+}(aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu^{2+}(aq)	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), Fe^{2+}(aq)	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), Fe^{3+}(aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg^{2+}(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn^{2+}(aq)	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, Zn^{2+}(aq)	white ppt. soluble in excess	white ppt. soluble in excess

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq))
bromide, Br^-(aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq))
nitrate, NO_3^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil; NO liberated by dilute acids (colourless NO $\rightarrow$ (pale) brown NO_2 in air)
sulfate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) (insoluble in excess dilute strong acids)
sulfite, SO_3^{2-}(aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acids)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	“pops” with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1.0 H Hydrogen 1										4.0 He Helium 2
6.9 Li Lithium 3	9.0 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	39.9 Ar Argon 18
39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	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	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	Ra Radium 88	Ac Actinium 89 †	Rf Rutherfordium 104	Db Dubnium 105	Sg Seaborgium 106	Bh Bohrium 107	Hs Hassium 108	Mt Meitnerium 109	Uun Ununnilium 110	Uuu Unununium 111	Uub Ununbium 112		Uuq Ununquadium 114		Uuh Ununhexium 116		Uuo Ununoctium 118

*58-71 Lanthanides
†90-103 Actinides

*	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
†	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number