

Cambridge International Examinations

Cambridge International Advanced Subsidiary and Advanced Level

NUMBER	NUMBER	
CENTRE	CANDIDATE	
CANDIDATE NAME		

CHEMISTRY

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.



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 cm³ of **FB 1** into the 250 cm³ 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 cm³ 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 cm³.

- 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)	in y	om your accurate titration results, obtain a suitable value for the volume of FB 2 to be used your calculations. ow clearly how you have obtained this value.		
		25.0 cm ³ of FB 3 required cm ³ of FB 2 . [1]		
(c)	Cal	culations		
		ow your working and appropriate significant figures in the final answer to each step of your culations.		
	(i)	Calculate the number of moles of sodium hydroxide present in 25.0 cm³ of solution FB 3 .		
		moles of NaOH = mol		
	(ii)	Give the equation for the reaction of hydrochloric acid, HC <i>l</i> , 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 $HCl = \dots mol$		
	(iii)	Calculate the number of moles of hydrochloric acid in 250 cm³ 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 cm³ of FB 1 with your weighed piece of magnesium. After the reaction, the unreacted hydrochloric acid was used to prepare 250 cm³ 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 HC1 reacting with Mg = mol
(vi)	Complete the equation below, for the reaction of magnesium with hydrochloric acid. State symbols are required.
	$\label{eq:mgcl2} \text{Mg} + \text{HC} l \rightarrow \text{MgC} l_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.
	101
	[3]

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[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, MgSO₄.7H₂O.

(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 ₂ O	=		mol
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(ii) Use the **equation above** and **your answer to (i)** to calculate the number of moles of anhydrous magnesium sulfate produced.

moles of $MgSO_4 = \dots mol$

(iii)	Use your weighings and your answer to (ii) to calculate the relative formula mass, $M_{\rm r}$, or anhydrous magnesium sulfate.
	$M_{\rm r}$ of MgSO ₄ =
(iv)	From your answer to (iii), calculate the relative atomic mass, $A_{\rm r}$, 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.

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.		
i)	Dissolve the remainder of FB 6 in abo in the following tests.	ut 20 cm³ of distilled water in a boiling tube	
i)		ut 20 cm³ of distilled water in a boiling tube	
To	in the following tests.		
To a sil	in the following tests. test a 1 cm depth of the solution of FB 6 in test-tube, add a few drops of aqueous		

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

,	reac	tion with
ion	NaOH(aq)	NH ₃ (aq)
aluminium, A <i>l</i> 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 [Ca2+(aq)]	no ppt.
chromium(III), Cr³+(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), Fe²+(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), Fe³+(aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg²+(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn²+(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, Zn²+(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, C <i>l</i> ⁻ (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 A <i>l</i> 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

	0	4.0 He lium	20.2 Ne Neon	39.9 Ar Argon	83.8 Kr	131 Xenon	Rn Radon	Uuo Ununoctium 118
		→ ∄	10	18	36	54	86	Unu 118
			19.0 F	35.5 C1 Chlorine	79.9 Br Bromine 35	127 	At Astatine 85	
	5		16.0 Oxygen 8	32.1 S Sulfur	79.0 Sel Selenium 34	128 Te Tellurium	Po Polonium 84	Uuh Ununhexium 116
	>		14.0 N itrogen 7	31.0 Phosphorus	74.9 AS Arsenic 33	122 Sb Antimony 51	209 Bi Bismuth 83	
	2		12.0 Carbon 6	28.1 Si Silicon	72.6 Ge Germanium	119 Sn □ □	207 Pb Lead 82	Uuq Ununquadium 114
	=		10.8 Boron	27.0 A1 Aluminium 13	69.7 Ga Gallium 31	115 n Indium 49	204 T 1 Thallium	
					65.4 Zn Zinc 30	Cadmium 48	201 Hg Mercury 80	Uub Ununbium
					63.5 Cu Copper	108 Ag Silver 47	197 Au Gold	Duu Unununium 111
Group					58.7 Ni Nickel	106 Pd Palladium 46	195 Pt Platinum 78	Cun Ununnilium
Ğ					58.9 Co Cobalt 27	Rhodium	192 r r	Mt Meitnerium 109
		1.0 T Hydrogen			55.8 Fe Iron	Ruthenium 44	190 Os Osmium 76	Hassium
					54.9 Mn Manganese 25	Tc Technetium 43	186 Re Rhenium 75	Bh Bohrium 107
					52.0 Cr Chromium 24	95.9 Mo Molybdenum 42	184 W Tungsten 74	Sg Seaborgium 106
					50.9 Vanadium 23	92.9 Nb Niobium 41		Db Dubnium 105
					47.9 Ti Titanium	91.2 Zr Zirconium 40	178 # ### Hafnium 72	Rutherfordium
					Scandium 21	88.9 ×	139 La Lanthanum 57 *	Actinium Actinium Actinium
	=		9.0 Be Beryllium	24.3 Mg Magnesium 12	40.1 Ca Calcium 20	87.6 Strontium	137 Ba Barium 56	Radium 88
	_		6.9 Li Lithium	23.0 Na Sodium	39.1 K Potassium	85.5 Rb Rubidium	Caesium	Fr Francium 87

4	*	140	141	144		150	152		159	163	165		169	173	
מווווש סליייים	inalides History	ce	Ą	N	Pm	Sm	Eu		₽ L	۵	운	ш	E E	Υb	
	O D	Cerium 58	Praseodymium 59	Neodymium 60	Promethium 61	Samarium 62	Europium 63	Gadolinium 64	Terbium 65	Dysprosium 66	Holmium 67	89	Thulium 69	Ytterbium 70	Lutetium 71
		0	3	3					3			- 1	3		
æ	a = relative atomic mass †														
×	X = atomic symbol	보	Ра	>	S N	Pu	Am	Cm	B	ర	Es	Fm	Md		۲
	b = proton (atomic) number	Thorium 90	Protactinium 91	Uranium 92	Neptunium 93	Plutonium 94	Americium 95	Curium 96	Berkelium 97	Californium 98	Einsteinium 99	Fermium 100	Mendelevium 101	Nobelium 102	Lawrendum 103

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