Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME		
CENTRE NUMBER		CANDIDATE NUMBER

5663637748

CHEMISTRY **9701/35**

Paper 3 Advanced Practical Skills 1 **May/June 2018**

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 copy of the 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

Quantitative Analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

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

1 In this experiment you will determine **x** in the formula of hydrated sodium carbonate, $Na_2CO_3.\mathbf{x}H_2O$, by titration.

FA 1 is hydrated sodium carbonate, $Na_2CO_3.\mathbf{x}H_2O$.
FA 2 is 0.110 mol dm^{-3} hydrochloric acid, HCl.
methyl orange indicator

(a) Method

Making a solution of FA 1

- Record all masses in the space below.
- Weigh the container with **FA 1**.
- Tip all the solid **FA 1** into the 250 cm^3 beaker.
- Weigh the container with any residual **FA 1**.
- Add approximately 100 cm^3 of distilled water to the beaker and stir to dissolve **FA 1**.
- Transfer the solution to the 250 cm^3 volumetric flask.
- Rinse the beaker twice, each time with about 20 cm^3 of distilled water, and add this to the volumetric flask.
- Add distilled water to the volumetric flask to make 250 cm^3 of solution and shake thoroughly. Label this solution **FA 3**.
- Calculate and record the mass of **FA 1** used to make this solution.

Titration

- Pipette 25.0 cm^3 of **FA 3** into a conical flask.
- Fill the burette with **FA 2**.
- Add several drops of methyl orange indicator to the conical flask.
- Carry out a **rough** titration and record your burette readings in the space below.

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

I	
II	
III	
IV	
V	
VI	
VII	

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

[7]

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

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

(c) Calculations

(i) Give your answers to **(ii)**, **(iii)** and **(iv)** to the appropriate number of significant figures. [1]

(ii) Calculate the number of moles of hydrochloric acid in the volume of **FA 2** calculated in **(b)**.

moles of HCl = ... mol [1]

(iii) Complete the equation below and include the missing state symbols.

$Na_2CO_3(aq)$ + $HCl(aq)$ → $NaCl$ + CO_2 + H_2O

Calculate the number of moles of sodium carbonate in 25.0 cm^3 of **FA 3**.

moles of Na_2CO_3 in 25.0 cm^3 of **FA 3** = ... mol [1]

(iv) Calculate the number of moles of sodium carbonate in 250.0 cm^3 of **FA 3**.

moles of Na_2CO_3 in 250.0 cm^3 of **FA 3** = ... mol

Use this answer and your data on page 2 to calculate the relative formula mass, M_r, of hydrated sodium carbonate, $Na_2CO_3.\mathbf{x}H_2O$.

M_r of $Na_2CO_3.\mathbf{x}H_2O$ = ...
[1]

(v) Calculate the value of **x** in $Na_2CO_3.\mathbf{x}H_2O$. Give your answer to the nearest whole number.

x = ... [1]

(d) A student suggested using 0.110 mol dm^{-3} sulfuric acid in place of the 0.110 mol dm^{-3} hydrochloric acid used in the experiment above. The mass of **FA 1** used was unchanged.

Explain what effect this change would have on the accuracy of the experiment.

....

....

....

.... [2]

[Total: 15]

2 In **Question 1** you used a titration method to investigate a hydrated compound. In **Question 2** you will use a method involving measuring masses. You will find the identity of a Group 2 element, **Y**, whose hydrated sulfate has the formula $\mathbf{Y}SO_4.7H_2O$.

When heated, the hydrated sulfate loses its water of crystallisation to form anhydrous sulfate. The anhydrous sulfate does not decompose at the temperature of the Bunsen flame.

$$\mathbf{Y}SO_4.7H_2O(s) \rightarrow \mathbf{Y}SO_4(s) + 7H_2O(g)$$

FA 4 is the hydrated sulfate of **Y**, $\mathbf{Y}SO_4.7H_2O$.

(a) Method

- Weigh the crucible with its lid and record the mass.
- Tip between 1.80 g and 2.00 g of **FA 4** into the crucible. **Keep the remaining FA 4 for Question 3.**
- Weigh and record the mass of crucible, lid and **FA 4**.
- Place the crucible on the pipe-clay triangle on the tripod. Put the lid on the crucible and heat gently for about 1 minute.
- Use tongs to remove the lid and heat the crucible strongly for about 4 minutes. Replace the lid and then leave to cool.
- While the crucible is cooling, begin work on **Question 3**.
- When cool, reweigh the crucible with its lid and contents and record the mass.
- Calculate and record the mass of **FA 4** before heating, the mass of residue after heating and the mass of water lost.

[4]

(b) Calculations

(i) Calculate the number of moles of water lost on heating **FA 4**.

moles of H_2O lost = ... mol [1]

(ii) Deduce the number of moles of anhydrous **Y**SO_4 that are formed when this water is lost.

moles of **Y**SO_4 = ... mol [1]

(iii) Use your answer to **(ii)** and the mass of residue left after heating **FA 4** to determine the relative atomic mass, A_r, of **Y**.

A_r of **Y** = ... [2]

(iv) Identify **Y**.

Y is .... [1]

(c) A student did not heat the sample of **FA 4** for long enough to remove all the water.

What would be the effect of this on the calculated value of the relative atomic mass of **Y**?

Explain your answer.

....

....

....

.... [2]

[Total: 11]

Qualitative Analysis

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

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

- colour changes seen;
- the formation of any precipitate and its solubility in an excess of the reagent added;
- the formation of any gas and its identification by a suitable test.

You should indicate clearly at what stage in a test a change occurs.

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

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

No additional tests for ions present should be attempted.

3 **(a)** In **Question 2** you used a gravimetric method to identify the cation, **Y**, present in **FA 4**. You will now use a qualitative analysis method to confirm whether your identification of **Y** was correct.

Transfer a spatula measure of **FA 4** into a boiling tube. Add a 5 cm depth of distilled water and shake the tube to dissolve the solid.

(i) Use 1 cm depths of this solution in test-tubes to carry out tests to identify the cation, **Y**, present in **FA 4**. Record your tests and observations in a suitable form in the space below.

[3]

(ii) Do your qualitative analysis tests in **(i)** confirm your identity of **Y** in **Question 2**? Explain your answer.

....

....

.... [1]

(b) **FA 5** contains **two** of the ions listed in the Qualitative Analysis Notes.

(i) Place a small spatula measure of **FA 5** into a hard-glass test-tube and heat, gently at first and then strongly. Record your observations.

observations ....

....

....

.... [2]

(ii) Transfer the remaining **FA 5** into the 100 cm^3 beaker. Add approximately 20 cm^3 of distilled water and stir to form a solution.

For each of the tests below use a separate 1 cm depth of this solution in a test-tube. Record your observations.

test	*observations*
Add aqueous sodium hydroxide.	
Add a few drops of acidified potassium manganate(VII), then	
add a few drops of ammonium thiocyanate. Tip the contents of the tube down the sink and rinse the tube and sink with tap water.	
Add a 1 cm depth of hydrogen peroxide, then	
add aqueous sodium hydroxide.	
Add a 1 cm depth of dilute nitric acid and then a few drops of aqueous silver nitrate.	
Add a few drops of aqueous barium nitrate or aqueous barium chloride, then	
add dilute hydrochloric acid.	

[6]

(iii) Identify the ions present in **FA 5**.

ions present .... and .... [1]

(iv) What **type** of reaction is occurring when **FA 5** reacts with acidified potassium manganate(VII)?

.... [1]

[Total:14]

Qualitative Analysis Notes

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)	faint white ppt. is nearly always observed unless 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	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
sulfate, $SO_4^{2-}(aq)$	gives white ppt. with $Ba^{2+}(aq)$ (insoluble in excess dilute strong acids)
sulfite, $SO_3^{2-}(aq)$	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

The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3											13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.4	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –