Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

2735324268

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **October/November 2017**

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	
Total	

This document consists of **12** printed pages and **1** Insert.

IB17 11_9701_34/4RP

CAMBRIDGE International Examinations

[Turn over

1 Sodium thiosulfate reacts with acid to produce a pale yellow precipitate of sulfur.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(aq) + H_2O(l)$$

You will investigate how the rate of this reaction varies with the concentration of thiosulfate ions. To do this you will measure the time taken for a fixed amount of sulfur to be formed.

FB 1 is 0.10 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
FB 2 is 1.00 mol dm^{-3} hydrochloric acid, HCl.

(a) Method

Read through the instructions and prepare a table on page 3 for your results before starting any practical work. You will need to include volume of **FB 1**, volume of water, reaction time and rate of reaction for each of the five experiments.

Experiment 1

- Use the larger measuring cylinder to transfer 40 cm^3 of **FB 1** into the 100 cm^3 beaker.
- Use the smaller measuring cylinder to measure 25 cm^3 of **FB 2**.
- Pour the **FB 2** into the **FB 1** in the beaker and start timing **immediately**.
- Stir the mixture in the beaker once and place the beaker on top of the printed insert provided.
- Look down through the solution in the beaker at the print on the insert.
- Stop timing as soon as the precipitate of sulfur makes the print on the insert **just** invisible.
- Record the reaction time to the nearest second.
- Empty, rinse and dry the beaker so it is ready for use in **Experiment 2**.
- Rinse the sink with tap water to wash away the products of the reaction.

Experiment 2

- Use the larger measuring cylinder to transfer 30 cm^3 of **FB 1** into the 100 cm^3 beaker.
- Use the same measuring cylinder to add 10 cm^3 of distilled water to the beaker.
- Use the smaller measuring cylinder to add 25 cm^3 of **FB 2** to the mixture in the beaker and start timing **immediately**.
- Stir the mixture in the beaker once and place the beaker on top of the printed insert provided.
- Look down through the solution in the beaker at the print on the insert.
- Stop timing as soon as the precipitate of sulfur makes the print on the insert **just** invisible.
- Record the reaction time to the nearest second.
- Empty, rinse and dry the beaker so it is ready for use in **Experiment 3**.
- Rinse the sink with tap water to wash away the products of the reaction.

Experiment 3

Repeat **Experiment 2** using 20 cm^3 of **FB 1**, 20 cm^3 of distilled water and 25 cm^3 of **FB 2**.

Experiments 4 and 5

Choose suitable volumes that will enable you to investigate further the effect of changing the concentration of thiosulfate ions on the rate of the reaction. You should not use a volume of less than 10 cm^3 of **FB 1**.

Results

The rate of the reaction can be calculated as shown.

$$\text{rate} = \frac{1000}{\text{reaction time}}$$

Calculate the rate of reaction for each experiment and complete the table.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	
IX	
X	

[10]

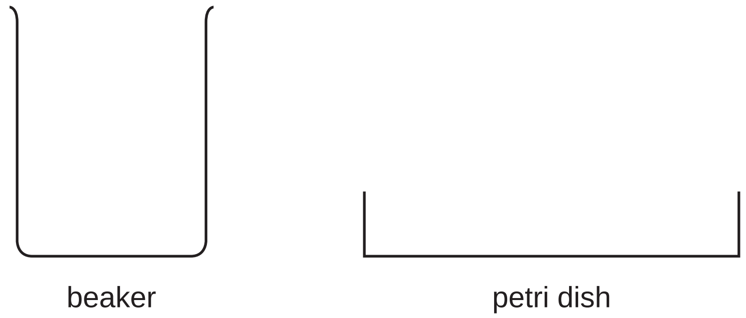
(b) On the grid plot a graph of rate of reaction (*y*-axis) against volume of **FB 1** (*x*-axis). Circle any points that you consider anomalous and draw a line of best fit to show how the rate of the reaction depends on the volume of **FB 1**.

[3]

(c) **Use your graph** to calculate the time that the reaction would have taken if 8 cm^3 of **FB 1** had been used. Show **on the grid** how you obtained your answer.

time = ... s [2]

(d) **(i)** A student broke the 100 cm^3 beaker when carrying out the experiment and decided to use a petri dish instead. This has a different shape.



State and explain what effect this would have on the student's results.

....

....

....

(ii) Another student suggested that the experiment could be improved by using a less concentrated solution of sodium thiosulfate.

Explain whether this suggestion would improve the accuracy of the results.

....

....

....
[4]

(e) Calculate the maximum percentage error in the reaction time for **Experiment 1**. Show how you obtained your answer.

maximum percentage error = ... % [1]

(f) Using a similar method to **(a)**, explain how you would investigate how the rate of the reaction varies with changes in the concentration of hydrochloric acid.

....

....

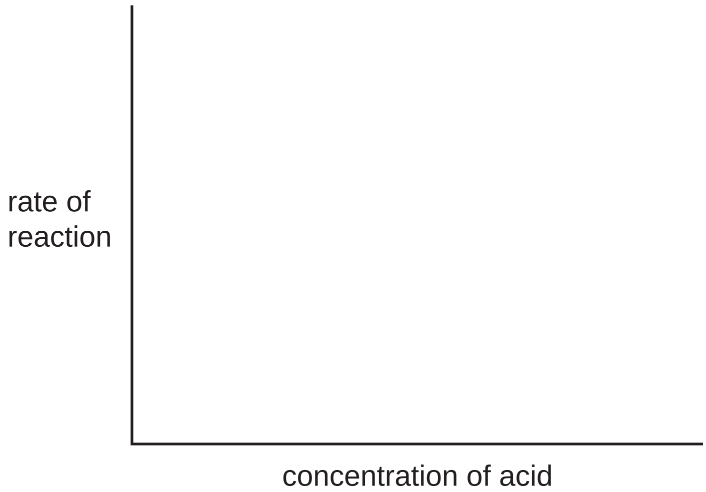
....

.... [3]

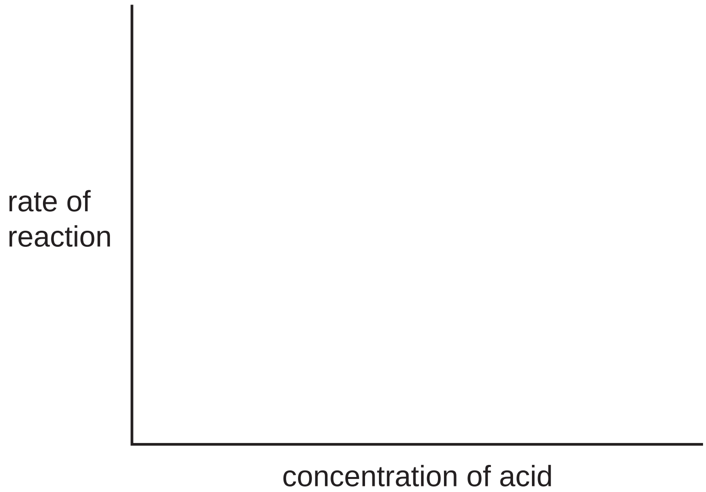
(g) An experiment to investigate the effect of changing the concentration of hydrochloric acid gave results that could be plotted to produce a graph.

On the axes, sketch the graph that would show that:

(i) the rate of reaction was directly proportional to the concentration of acid,



(ii) the rate of reaction did **not** depend on the concentration of acid.



[2]

[Total: 25]

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

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.
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.

(a) **FB 3**, **FB 4**, **FB 5** and **FB 6** are aqueous solutions each containing one cation and one anion.

(i) Carry out the following tests by adding, to a 1 cm depth of each solution in a test-tube, a 1 cm depth of the other solution. Record your observations in the table.

test	*observations*		
	FB 4	**FB 5**	**FB 6**
FB 3			
FB 4			
FB 5			

(ii) **FB 3** and **FB 4** both contain the same anion.

Use your observations from **(i)** to suggest the identity of this anion.

anion: ....

(iii) Suggest and carry out a test to confirm the identity of the anion you identified in **(ii)**. You should include the test and your result.

test ....

result ....

(iv) **FB 5** contains one cation from those listed in the Qualitative Analysis Notes.

Use your observations in **(i)** to suggest **two** cations that could be present in **FB 5**.

cations present .... or ....

(v) Suggest and carry out a test to identify which of the cations you suggested in **(iv)** is present in **FB 5**.

test ....

result ....

cation present in **FB 5** ....

[9]

(b) **FB 7**, **FB 8** and **FB 9** are aqueous solutions.

(i) Carry out the following tests and record your observations.

test	*observations*		
	FB 7	**FB 8**	**FB 9**
To a 1 cm depth of solution in a test-tube add a 1 cm depth of aqueous potassium iodide, then			
add aqueous starch.			
To a 1 cm depth of solution in a test-tube add a 1 cm depth of aqueous iodine.			
To a 1 cm depth of solution in a test-tube add a few drops of aqueous barium nitrate or aqueous barium chloride.			

(ii) From your observations in **(i)** suggest **two** anions from those listed in the Qualitative Analysis Notes that could be present in **FB 9**.

anions present .... or ....

(iii) Suggest and carry out a test to identify which of the anions you suggested in **(ii)** is present in **FB 9**.

test ....

result ....

anion present in **FB 9** ....
[6]

[Total: 15]

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; 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)	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 –