

--

--	--	--	--	--

--	--	--	--

9701/31

October/November 2011

2 hours

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

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 8 and 9.

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 **9** printed pages and **3** blank pages.

- 1 You are to determine the enthalpy change of neutralisation of hydrochloric acid by aqueous sodium hydroxide and also the concentration of the aqueous sodium hydroxide. These can be found by measuring the temperature change when solutions of the acid and alkali are mixed.

FA 1 is aqueous sodium hydroxide, NaOH.

FA 2 is 2.00 mol dm⁻³ hydrochloric acid, HCl.

(a) Method

- Fill a burette with **FA 1**. [**Care: FA 1 is corrosive**]
- Support the plastic cup in a 250 cm³ beaker.
- Use a measuring cylinder to transfer 25 cm³ of **FA 2** into a 100 cm³ beaker.
- Use a measuring cylinder to add 35 cm³ of distilled water to the acid in the beaker.
- Measure and record, in the table below, the initial temperature of the mixture in the beaker.
- Run 5.0 cm³ of **FA 1** from the burette into the plastic cup.
- Add the mixture of acid and water from the 100 cm³ beaker to the **FA 1** in the plastic cup.
- Stir carefully and measure the highest temperature obtained.
- Record this temperature in the table.
- Rinse the plastic cup with water.
- Repeat the experiment using 25 cm³ of **FA 2**, 30 cm³ of distilled water and 10.0 cm³ of **FA 1** as shown for experiment 2 in the table.
- Carry out experiments 3 to 7 in the same way.
- Complete the table for each experiment.

Results

<i>experiment number</i>	1	2	3	4	5	6	7
volume of FA 2 / cm ³	25	25	25	25	25	25	25
volume of water / cm ³	35	30	25	20	15	10	5
volume of FA 1 / cm ³	5.0	10.0	15.0	20.0	25.0	30.0	35.0
initial temperature of acid mixture / °C							
highest temperature / °C							
temperature change / °C							

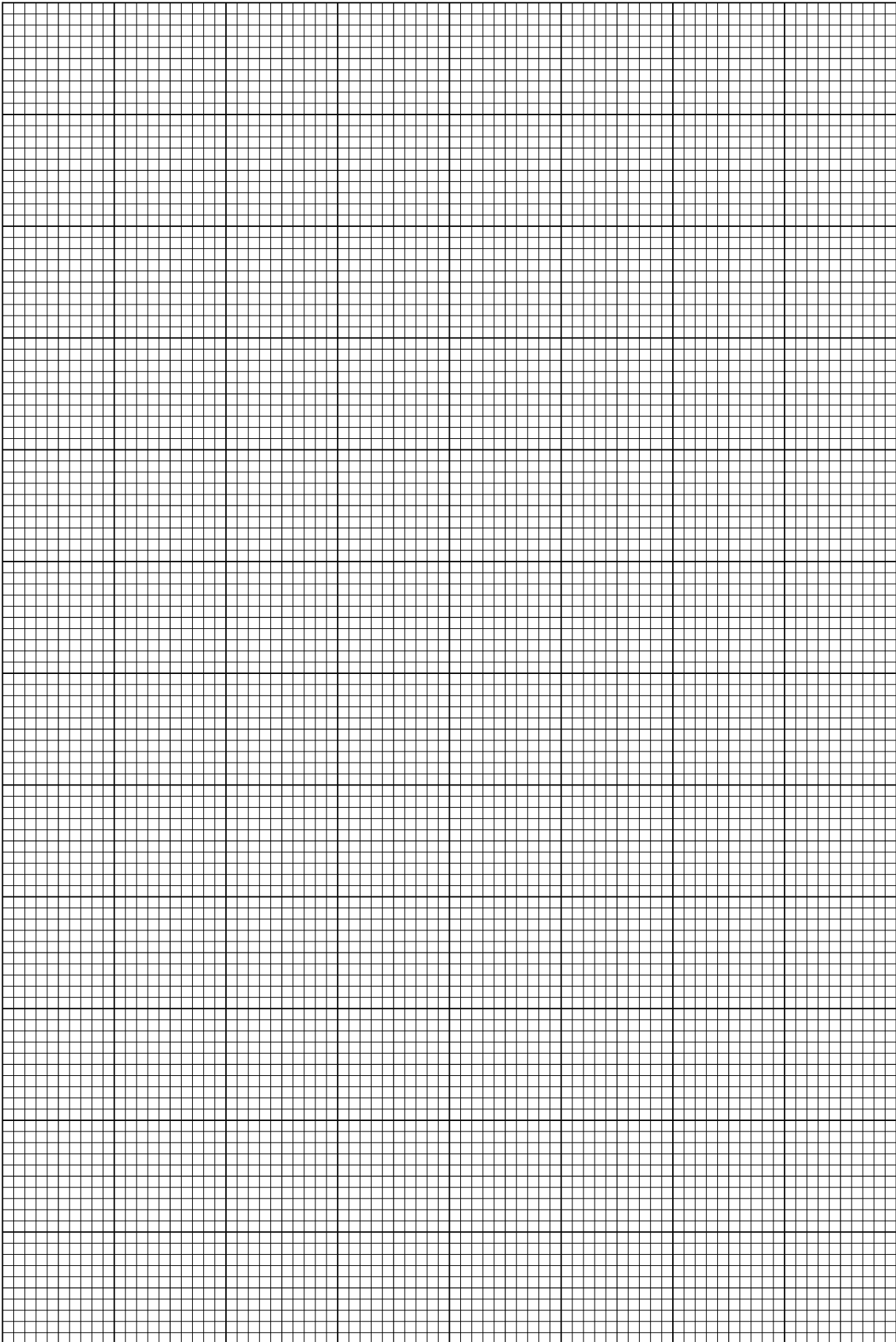
[7]

For
Examiner's
Use

I	
II	
III	
IV	
V	
VI	
VII	

- (b) On the grid below plot the temperature **change** (y -axis) against the volume of **FA 1** (x -axis). Using these points, draw two straight lines that intersect.

For
Examiner's
Use



I	
II	
III	
IV	

[4]

- [1]

.....

.....

.....

..... [2]

- enthalpy change of neutralisation = ... kJ mol⁻¹
sign *value* [2]

- (h) Explain why the **total** volume of solution used was kept constant in each of the experiments.

.....

 [1]

- (i) Calculate the concentration, in mol dm^{-3} , of the aqueous sodium hydroxide, **FA 1**.

concentration of **FA 1** = ... mol dm^{-3} [2]

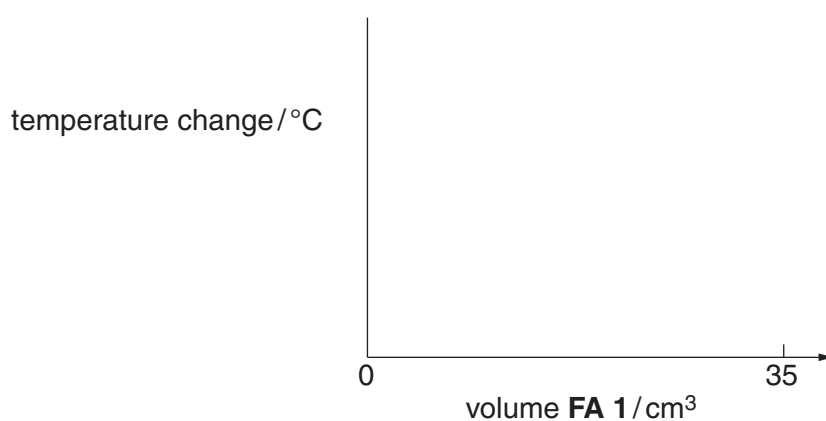
- (j) A student thought that the experiment was not accurate because the temperature changes measured were small.

Suggest a modification to the experimental method used in order to give larger changes in temperature.

.....
 [1]

- (k) Experiments **1** to **7** were repeated using 1.00 mol dm^{-3} sulfuric acid, H_2SO_4 , instead of the 2.00 mol dm^{-3} hydrochloric acid, HCl .

On the axes below indicate an appropriate temperature scale and sketch the graph for the temperature changes you would expect.



[2]

[Total: 25]

2 Qualitative Analysis

For
Examiner's
Use

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 full name or correct formula of the reagents must be given.

- (a) You are provided with three sodium salts **FA 3**, **FA 4** and **FA 5**. Each salt contains **one** of the ions carbonate, CO_3^{2-} , sulfite, SO_3^{2-} or sulfate, SO_4^{2-} .

- (i) Using your knowledge of the reactions of these ions, suggest **one** reagent you could add to the solid to find out which ion is present in each of the solids.

.....

- (ii) Use the reagent you selected in (i) to identify which of these ions is present in **FA 3**, **FA 4** and **FA 5**.

Carry out suitable tests on a small amount of each solid and record the results of your experiments in an appropriate form in the space below.

I	
II	
III	
IV	
V	
VI	

Identify the anions in **FA 3**, **FA 4** and **FA 5**.

FA 3 contains the ion.

FA 4 contains the ion.

FA 5 contains the ion.

[6]

- (b) (i) You are provided with **FA 6** both as a solid and in aqueous solution. Complete the following table.

For
Examiner's
Use

<i>test</i>	<i>observations</i>
To a small spatula measure of FA 4 in a test-tube, add enough distilled water to make a solution. Add 1 cm depth of FA 6 solution.	
To a small spatula measure of FA 5 in a test-tube, add enough distilled water to make a solution. Add 1 cm depth of FA 6 solution.	
To 1 cm depth of FA 6 solution in a test-tube, add aqueous sodium hydroxide.	
Carefully heat the solid FA 6 in the test-tube provided. Note: two gases are released.	

I	
II	
III	
IV	
V	
VI	

[6]

- (ii) From the results of the tests in (i), identify the cation present in **FA 6**.

Cation present in **FA 6** is

[1]

- (iii) Suggest and use another reagent to confirm the cation present in **FA 6**.

reagent

observation.....[2]

[Total: 15]

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
lead(II), Pb ²⁺ (aq)	white ppt. soluble in excess	white 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

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

<i>ion</i>	<i>reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-} (aq)	yellow solution turns orange with H^+ (aq); gives yellow ppt. with Ba^{2+} (aq); gives bright yellow ppt. with Pb^{2+} (aq)
chloride, Cl^- (aq)	gives white ppt. with Ag^+ (aq) (soluble in NH_3 (aq)); gives white ppt. with Pb^{2+} (aq)
bromide, Br^- (aq)	gives cream ppt. with Ag^+ (aq) (partially soluble in NH_3 (aq)); gives white ppt. with Pb^{2+} (aq)
iodide, I^- (aq)	gives yellow ppt. with Ag^+ (aq) (insoluble in NH_3 (aq)); gives yellow ppt. with Pb^{2+} (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) or with Pb^{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)

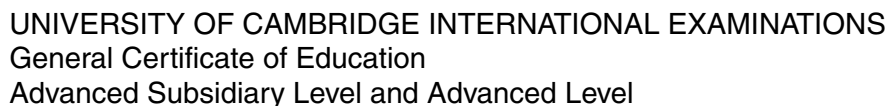
3 Tests for gases

<i>gas</i>	<i>test and test result</i>
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 dichromate(VI) from orange to green

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9701/33

October/November 2011

2 hours

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

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 8 and 9.

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 **9** printed pages and **3** blank pages.

- 1 You are to determine the enthalpy change of neutralisation of hydrochloric acid by aqueous sodium hydroxide and also the concentration of the aqueous sodium hydroxide. These can be found by measuring the temperature change when solutions of the acid and alkali are mixed.

For
Examiner's
Use

FA 1 is aqueous sodium hydroxide, NaOH.

FA 2 is 2.00 mol dm⁻³ hydrochloric acid, HCl.

(a) Method

- Fill a burette with **FA 1**. [**Care: FA 1 is corrosive**]
- Support the plastic cup in a 250 cm³ beaker.
- Use a measuring cylinder to transfer 25 cm³ of **FA 2** into a 100 cm³ beaker.
- Use a measuring cylinder to add 35 cm³ of distilled water to the acid in the beaker.
- Measure and record, in the table below, the initial temperature of the mixture in the beaker.
- Run 5.0 cm³ of **FA 1** from the burette into the plastic cup.
- Add the mixture of acid and water from the 100 cm³ beaker to the **FA 1** in the plastic cup.
- Stir carefully and measure the highest temperature obtained.
- Record this temperature in the table.
- Rinse the plastic cup with water.
- Repeat the experiment using 25 cm³ of **FA 2**, 30 cm³ of distilled water and 10.0 cm³ of **FA 1** as shown for experiment 2 in the table.
- Carry out experiments 3 to 7 in the same way.
- Complete the table for each experiment.

Results

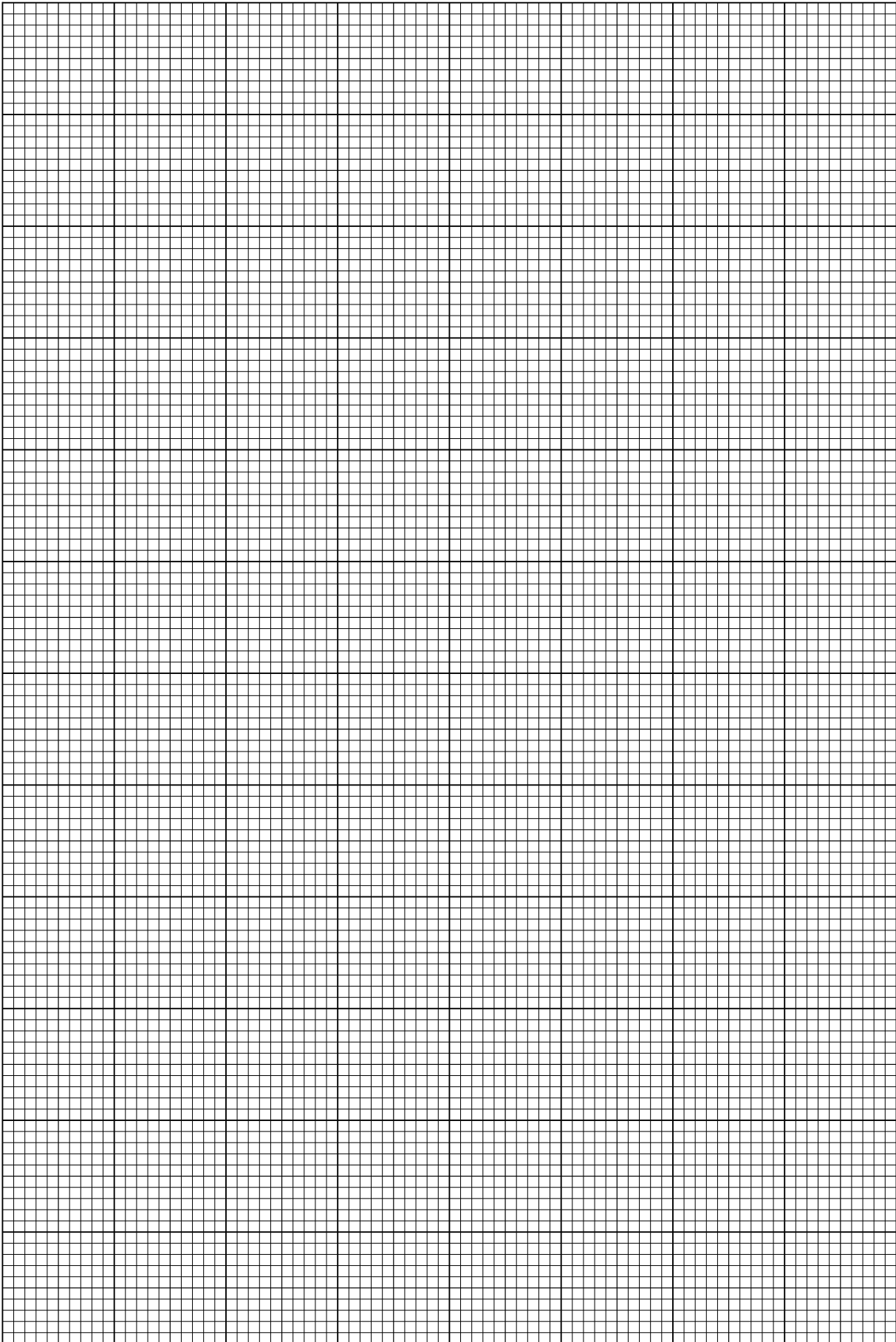
<i>experiment number</i>	1	2	3	4	5	6	7
volume of FA 2 / cm ³	25	25	25	25	25	25	25
volume of water / cm ³	35	30	25	20	15	10	5
volume of FA 1 / cm ³	5.0	10.0	15.0	20.0	25.0	30.0	35.0
initial temperature of acid mixture / °C							
highest temperature / °C							
temperature change / °C							

[7]

I	
II	
III	
IV	
V	
VI	
VII	

- (b) On the grid below plot the temperature **change** (y -axis) against the volume of **FA 1** (x -axis). Using these points, draw two straight lines that intersect.

For
Examiner's
Use



I	
II	
III	
IV	

[4]

- [1]

.....

.....

.....

..... [2]

- enthalpy change of neutralisation = ... kJ mol⁻¹
sign *value* [2]

- (h) Explain why the **total** volume of solution used was kept constant in each of the experiments.

.....

 [1]

- (i) Calculate the concentration, in mol dm^{-3} , of the aqueous sodium hydroxide, **FA 1**.

concentration of **FA 1** = ... mol dm^{-3} [2]

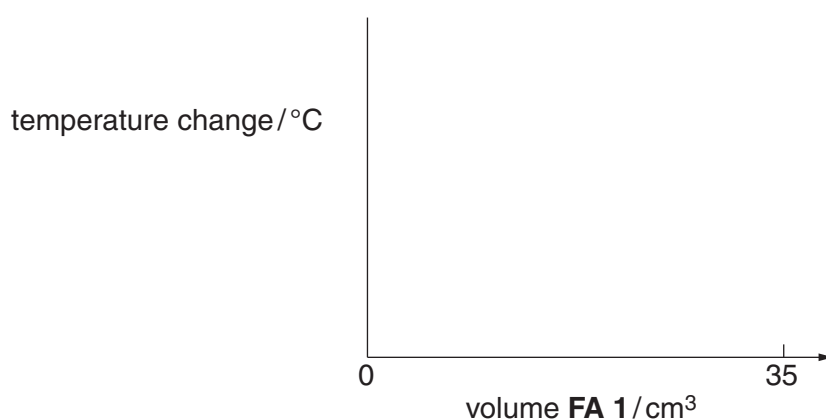
- (j) A student thought that the experiment was not accurate because the temperature changes measured were small.

Suggest a modification to the experimental method used in order to give larger changes in temperature.

.....
 [1]

- (k) Experiments **1** to **7** were repeated using 1.00 mol dm^{-3} sulfuric acid, H_2SO_4 , instead of the 2.00 mol dm^{-3} hydrochloric acid, HCl .

On the axes below indicate an appropriate temperature scale and sketch the graph for the temperature changes you would expect.



[2]

[Total: 25]

2 Qualitative Analysis

For
Examiner's
Use

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 full name or correct formula of the reagents must be given.

(a) You are provided with three sodium salts **FA 3**, **FA 4** and **FA 5**. Each salt contains **one** of the ions carbonate, CO_3^{2-} , sulfite, SO_3^{2-} or sulfate, SO_4^{2-} .

- (i) Using your knowledge of the reactions of these ions, suggest **one** reagent you could add to the solid to find out which ion is present in each of the solids.

.....

- (ii) Use the reagent you selected in (i) to identify which of these ions is present in **FA 3**, **FA 4** and **FA 5**.

Carry out suitable tests on a small amount of each solid and record the results of your experiments in an appropriate form in the space below.

I	
II	
III	
IV	
V	
VI	

Identify the anions in **FA 3**, **FA 4** and **FA 5**.

FA 3 contains the ion.

FA 4 contains the ion.

FA 5 contains the ion.

[6]

- (b) (i) You are provided with **FA 6** both as a solid and in aqueous solution. Complete the following table.

For
Examiner's
Use

<i>test</i>	<i>observations</i>
To a small spatula measure of FA 4 in a test-tube, add enough distilled water to make a solution. Add 1 cm depth of FA 6 solution.	
To a small spatula measure of FA 5 in a test-tube, add enough distilled water to make a solution. Add 1 cm depth of FA 6 solution.	
To 1 cm depth of FA 6 solution in a test-tube, add aqueous sodium hydroxide.	
Carefully heat the solid FA 6 in the test-tube provided. Note: two gases are released.	

I	
II	
III	
IV	
V	
VI	

[6]

- (ii) From the results of the tests in (i), identify the cation present in **FA 6**.

Cation present in **FA 6** is

[1]

- (iii) Suggest and use another reagent to confirm the cation present in **FA 6**.

reagent

observation.....[2]

[Total: 15]

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
lead(II), Pb ²⁺ (aq)	white ppt. soluble in excess	white 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

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

<i>ion</i>	<i>reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), $\text{CrO}_4^{2-}(\text{aq})$	yellow solution turns orange with $\text{H}^+(\text{aq})$; gives yellow ppt. with $\text{Ba}^{2+}(\text{aq})$; gives bright yellow ppt. with $\text{Pb}^{2+}(\text{aq})$
chloride, $\text{Cl}^-(\text{aq})$	gives white ppt. with $\text{Ag}^+(\text{aq})$ (soluble in $\text{NH}_3(\text{aq})$); gives white ppt. with $\text{Pb}^{2+}(\text{aq})$
bromide, $\text{Br}^-(\text{aq})$	gives cream ppt. with $\text{Ag}^+(\text{aq})$ (partially soluble in $\text{NH}_3(\text{aq})$); gives white ppt. with $\text{Pb}^{2+}(\text{aq})$
iodide, $\text{I}^-(\text{aq})$	gives yellow ppt. with $\text{Ag}^+(\text{aq})$ (insoluble in $\text{NH}_3(\text{aq})$); gives yellow ppt. with $\text{Pb}^{2+}(\text{aq})$
nitrate, $\text{NO}_3^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil
nitrite, $\text{NO}_2^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil; NO liberated by dilute acids (colourless $\text{NO} \rightarrow$ (pale) brown NO_2 in air)
sulfate, $\text{SO}_4^{2-}(\text{aq})$	gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ or with $\text{Pb}^{2+}(\text{aq})$ (insoluble in excess dilute strong acids)
sulfite, $\text{SO}_3^{2-}(\text{aq})$	SO_2 liberated with dilute acids; gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (soluble in excess dilute strong acids)

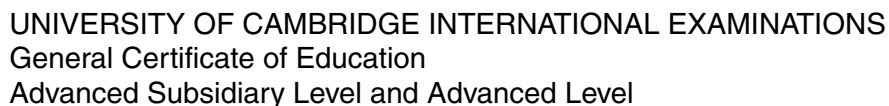
3 Tests for gases

<i>gas</i>	<i>test and test result</i>
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 dichromate(VI) from orange to green

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9701/34

October/November 2011

2 hours

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.
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.

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 **11** printed pages and **1** blank page.

- 1 You are to determine the enthalpy change of neutralisation of sodium hydroxide by an acid and also the concentration of hydrogen ions in the acid. These can be found by measuring the temperature change when solutions of the acid and alkali are mixed.

For
Examiner's
Use

FB 1 is 1.50 mol dm^{-3} sodium hydroxide, NaOH.

FB 2 is an aqueous solution of an acid.

(a) Method

- Fill a burette with **FB 1**. [**Care: FA1 is corrosive**]
- Support the plastic cup in a 250 cm^3 beaker.
- Run 10.0 cm^3 of **FB 1** from the burette into the plastic cup.
- Measure and record, in the table below, the temperature of the **FB 1** in the cup. You may need to tilt the beaker to ensure that the bulb of the thermometer is covered.
- Measure 40 cm^3 of **FB 2** using the measuring cylinder.
- Pour this volume of **FB 2** into the plastic cup containing **FB 1**. Stir carefully and measure the highest temperature obtained.
- Record this temperature in the table.
- Rinse the plastic cup with water.
- Repeat the experiment using 15.0 cm^3 of **FB 1** and 35 cm^3 of **FB 2** as shown for experiment **2** in the table.
- Carry out experiments **3** to **7** in the same way.
- Complete the table for each experiment.

Results

<i>experiment number</i>	1	2	3	4	5	6	7		
volume of FB 1 / cm^3	10.0	15.0	20.0	25.0	30.0	35.0	40.0	50.0	0.0
volume of FB 2 / cm^3	40	35	30	25	20	15	10	0	50
initial temperature FB 1 /°C									
highest temperature/°C									
temperature change/°C								0.0	0.0

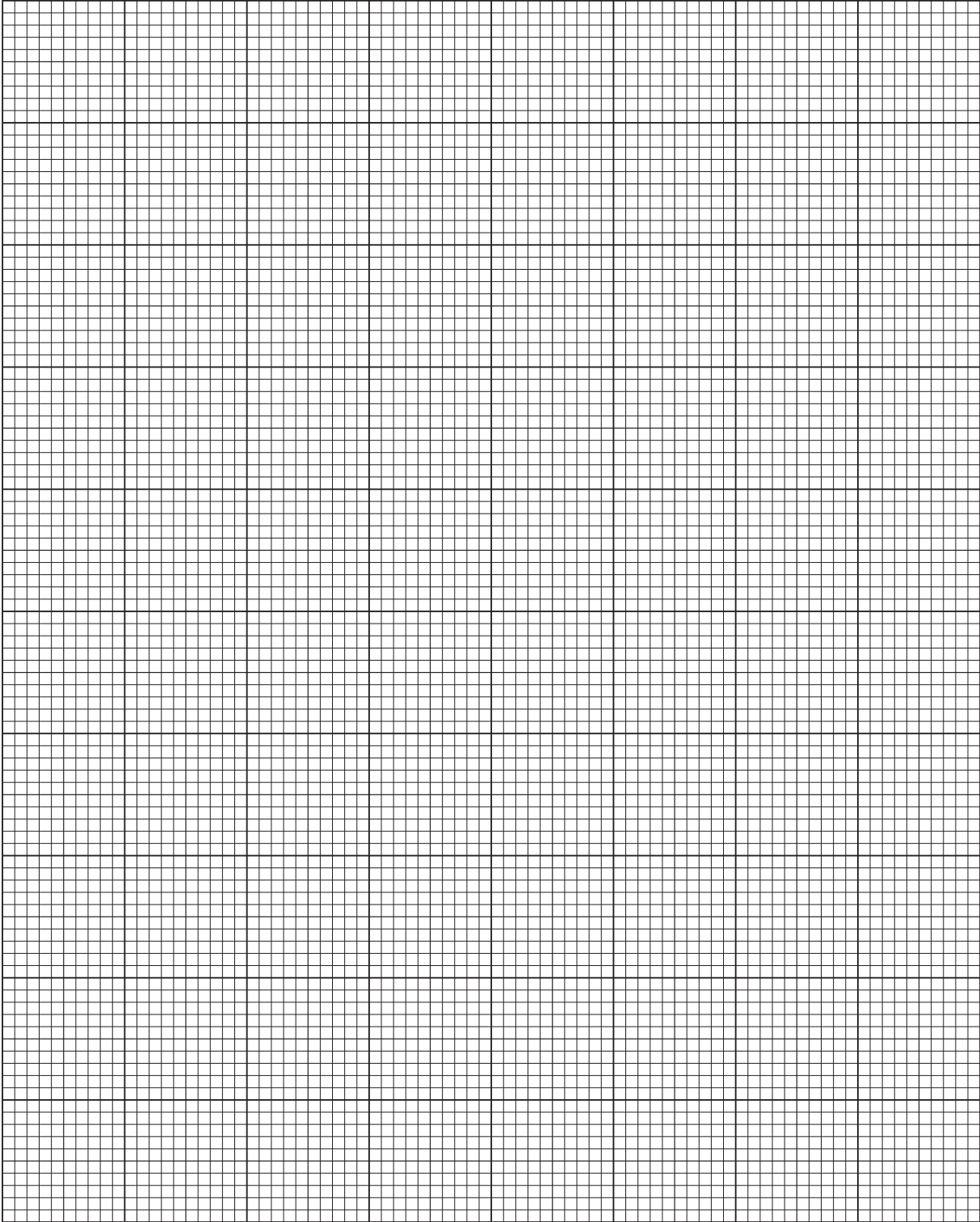
[8]

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

- (b) On the grid below plot the temperature **change** (y-axis) against the volume of **FB 1** (x-axis). Use **all** the results in the table including those provided in the final two columns.

For
Examiner's
Use

Using these points, draw two straight lines that intersect.



[4]

I	
II	
III	
IV	

- largest temperature change = ... °C

- volume of **FB 1** required is = ... cm³

- moles of sodium hydroxide present = ... mol

- [Assume that 4.3J are required to raise the temperature of 1 cm³ of any solution by 1°C]

heat energy produced = ... J

- Give your answer in kJ mol^{-1} and include the relevant sign.

enthalpy change of neutralisation = ... kJ mol⁻¹
sign value

I	
II	
III	
IV	
V	
VI	
VII	

- (d) Identify a source of error, other than heat loss, in the experimental method. Suggest an improvement which would reduce this source of error.

For
Examiner's
Use

.....

.....

.....

..... [2]

- (e) (i) Calculate the concentration of hydrogen ions, H^+ , in mol dm^{-3} , present in **FB 2**.

concentration of hydrogen ions in **FB 2** = ... mol dm^{-3}

- (ii) If the acid present in **FB 2** is sulfuric acid, calculate its concentration.

concentration of sulfuric acid = ... mol dm^{-3}

- (iii) Describe a chemical test by which you could prove that the acid in **FB 2** is sulfuric acid.

Do not carry out the test.

.....

.....

.....

.....

[4]

[Total: 25]

I	
II	
III	
IV	

2 Qualitative Analysis

For
Examiner's
Use

At each stage of any test you are to record the 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 full name or correct formula of the reagents must be given.

- (a) (i) **FB 3, FB 4 and FB 5** are aqueous solutions of sodium compounds. None of these compounds contains sulfur.

To about 1 cm depth of each of the solutions in separate test-tubes add the same depth of dilute sulfuric acid.

To another 1 cm depth of each of the solutions in separate test-tubes add a few drops of aqueous lead(II) nitrate.

Record your observations for these tests in an appropriate form in the space below.

I	
II	
III	
IV	
V	
VI	

Using the Qualitative Analysis Notes printed on pages 10 and 11 and your observations identify the anions in **FB 3** and **FB 4**.

For
Examiner's
Use

FB 3 contains

FB 4 contains

[6]

- (ii) Select a reagent or pair of reagents that would enable you to determine the identity of the anion in **FB 5**.

reagent(s)

Carry out a test on **FB 5** using the reagent(s) given above. Record your observations below.

.....

.....

.....

I	
II	
III	

The anion present in **FB5** is

[3]

(b) You are provided with solid **FB 6**. Complete the following table.

For
Examiner's
Use

<i>test</i>		<i>observations</i>
(i)	To 1 cm depth of aqueous hydrogen peroxide in a test-tube, add a very small spatula measure of FB 6 .	
(ii)	To 1 cm depth of aqueous iron(II) sulfate in a boiling tube, add the same depth of dilute sulfuric acid. Add a very small spatula measure of FB 6 to the tube. Warm the mixture gently using a Bunsen burner for about 20 seconds, then filter the warm mixture and collect the filtrate.	
	To the filtrate, add aqueous sodium hydroxide.	
(iii)	To 2 cm depth of aqueous potassium manganate(VII) in a test-tube, add the same depth of aqueous sodium hydroxide and then a small spatula measure of FB 6 . Stir the contents of the test-tube for about 20 seconds. Filter the mixture and collect the filtrate.	
	To the filtrate, add dilute sulfuric acid.	

Suggest a conclusion that could be made about the chemical behaviour of **FB 6** from the observations in **(i)**. Explain the reasons for your answer.

.....

What conclusion can be made about the chemical behaviour of **FB 6** from the observations in **(ii)**?

.....

[6]

[Total: 15]

*For
Examiner's
Use*

I	
II	
III	
IV	
V	
VI	

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
lead(II), Pb ²⁺ (aq)	white ppt. soluble in excess	white 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

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

<i>ion</i>	<i>reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), $\text{CrO}_4^{2-}(\text{aq})$	yellow solution turns orange with $\text{H}^+(\text{aq})$; gives yellow ppt. with $\text{Ba}^{2+}(\text{aq})$; gives bright yellow ppt. with $\text{Pb}^{2+}(\text{aq})$
chloride, $\text{Cl}^-(\text{aq})$	gives white ppt. with $\text{Ag}^+(\text{aq})$ (soluble in $\text{NH}_3(\text{aq})$); gives white ppt. with $\text{Pb}^{2+}(\text{aq})$
bromide, $\text{Br}^-(\text{aq})$	gives cream ppt. with $\text{Ag}^+(\text{aq})$ (partially soluble in $\text{NH}_3(\text{aq})$); gives white ppt. with $\text{Pb}^{2+}(\text{aq})$
iodide, $\text{I}^-(\text{aq})$	gives yellow ppt. with $\text{Ag}^+(\text{aq})$ (insoluble in $\text{NH}_3(\text{aq})$); gives yellow ppt. with $\text{Pb}^{2+}(\text{aq})$
nitrate, $\text{NO}_3^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil
nitrite, $\text{NO}_2^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil; NO liberated by dilute acids (colourless $\text{NO} \rightarrow$ (pale) brown NO_2 in air)
sulfate, $\text{SO}_4^{2-}(\text{aq})$	gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ or with $\text{Pb}^{2+}(\text{aq})$ (insoluble in excess dilute strong acids)
sulfite, $\text{SO}_3^{2-}(\text{aq})$	SO_2 liberated with dilute acids; gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (soluble in excess dilute strong acids)

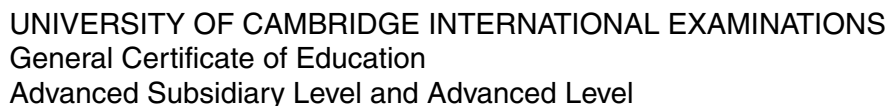
3 Tests for gases

<i>gas</i>	<i>test and test result</i>
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 dichromate(VI) from orange to green

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--	--	--	--	--

--	--	--	--

9701/35

October/November 2011

2 hours

Additional Materials: As listed in the Confidential Instructions

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

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 11 and 12.

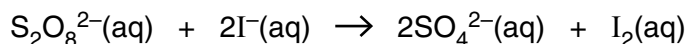
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
Total	

This document consists of **10** printed pages and **2** blank pages.

- 1 You are required to investigate the effect of temperature on the rate of reaction of peroxydisulfate ions with iodide ions. Iodide ions are oxidised to iodine by peroxydisulfate ions.



FA 1 is aqueous potassium peroxydisulfate, $\text{K}_2\text{S}_2\text{O}_8$.

FA 2 is an aqueous solution containing a mixture of potassium iodide, KI, sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, and starch.

When **FA 1** and **FA 2** are mixed together the potassium peroxydisulfate reacts with the potassium iodide to make iodine. As soon as this iodine is formed, it reacts with the sodium thiosulfate and is turned back into iodide ions. Only when all the sodium thiosulfate has reacted does iodine remain in the solution. The solution then turns blue-black because of the presence of the starch indicator. The rate of reaction can be determined by the time it takes for a blue-black colour to first appear in the colourless mixture.

(a) Method

Read through the method and prepare a table on page 3 to record the initial and final temperatures and the reaction time for each experiment, before starting any practical work.

- Half-fill a 250cm^3 beaker with water to act as a water bath.
- Place it on a tripod and gauze and heat it with a Bunsen burner to about 65°C then remove the Bunsen. While your water is being heated continue with the following steps of the method.
- Fill the burette, labelled **FA 1**, with the aqueous potassium peroxydisulfate, **FA 1**.
- Fill the burette, labelled **FA 2**, with the mixture of solutions, **FA 2**.
- Measure 10.0cm^3 of **FA 1** into a boiling tube.
- Measure 10.0cm^3 of **FA 2** into a second boiling tube.
- Place both boiling tubes in the water bath.
- Clamp one of the tubes and place a thermometer in this tube.
- When the temperature of this solution has reached about 60°C , pour the contents of the second tube into the clamped tube. Start timing immediately, note the temperature and stir the mixture.
- Record this initial temperature.
- Stop timing as soon as the blue-black colour appears. Record this reaction time to the **nearest second** and record the final temperature.
- Repeat the experiment at decreasing temperatures as many times as necessary to generate data for plotting a graph. The experiment should not be performed at a temperature below about 30°C . The temperature of the water bath may be adjusted by adding cold water or by reheating. (Boiling tubes may be rinsed and reused.)

I	
II	
III	
IV	
V	

$$\text{'rate'} = \frac{1000}{\text{reaction time in seconds}}$$

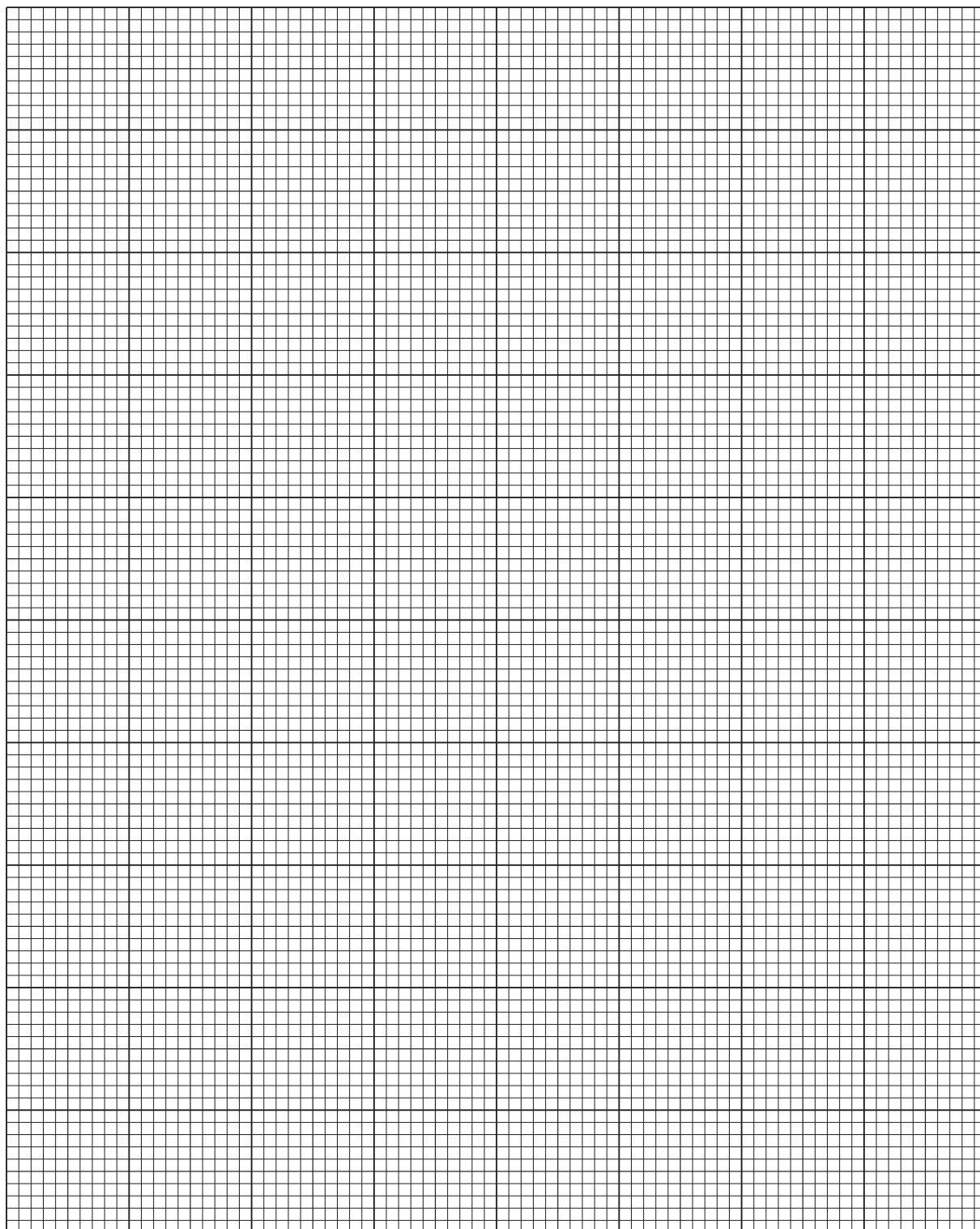
mean temperature / °C	'rate'

I	
II	
III	
IV	
V	
VI	

[Turn over

- (c) (i) Using your values in (b), plot a graph of 'rate' (y-axis) against mean temperature (x-axis). Choose suitable scales to allow you to extrapolate the graph to include the 'rate' at 20 °C.

For
Examiner's
Use



I	
II	
III	
IV	

- (ii) Use your graph to obtain a value for the 'rate' at 20 °C.

'rate' at 20 °C is [4]

- (d) It has been suggested that an increase in temperature of 10°C will double the rate of reaction. Use two pairs of temperatures from your graph to confirm or deny this statement.

.....
.....
.....
..... [2]

- (e) (i) Which of your experiments has the greatest percentage error in timing?

.....

- (ii) Calculate the percentage error in (i).
You may assume that the error in measuring the time for a reaction is ± 0.5 seconds.

error in (i) = ... % [2]

- (f) A student had difficulty in drawing a line of best fit. Identify a source of error in the experimental **procedure**. Do not include any errors involving the precision of apparatus.

.....
..... [1]

- (g) Suggest a modification that could be used to reduce this error.

.....
..... [1]

- (h) Using **FA 1**, **FA 2** and distilled water, describe how you could investigate the effect of **concentration** of potassium peroxydisulfate on the rate of reaction.

.....
.....
.....
.....
..... [3]

[Total: 24]

2 Qualitative analysis

For
Examiner's
Use

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 full name or correct formula of the reagents must be given.

FA 3, FA 4 and FA 5 are aqueous solutions containing one cation and one anion. One of these solutions is a dilute acid and this is the only acid present.

- (a) (i) Select a single chemical reagent from those supplied which would allow you to identify the dilute acid. You may not use indicator paper.

reagent

- (ii) Use this reagent to test all three solutions and record your results in an appropriate form in the space below.

I	
II	
III	
IV	
V	

- (iii) From your observations in (ii), identify which solution is the dilute acid.

FA is the dilute acid.

[5]

- (b) The acid you have identified in (a)(iii) is dilute sulfuric acid.
Complete the following table.

For
Examiner's
Use

<i>test</i>	<i>observations</i>
To 1 cm depth of FA 3 in a test-tube, add 1 cm depth of FA 4 , then	
add excess hydrochloric acid.	
To 1 cm depth of FA 4 in a test-tube, add 1 cm depth of FA 5 , then	
add excess hydrochloric acid.	
To 1 cm depth of FA 5 in a test-tube, add 1 cm depth of FA 3 , then	
add excess hydrochloric acid.	

[4]

I	
II	
III	
IV	

- (c) For the two unidentified solutions, complete the following table.

<i>test</i>	<i>observations</i>	
	FA	FA
To 1 cm depth of unknown in a boiling tube, add NaOH(aq)		
warm the tube carefully		

[2]

- (d) From your observations in (a), (b) and (c), identify the ions present in the two solutions tested in (c), giving the relevant evidence for each. If you have not been able to identify one or more of the ions, explain why the evidence obtained was insufficient.

For
Examiner's
Use

FA cation evidence

.....

.....

anion evidence

.....

.....

FA cation evidence

.....

.....

anion evidence

.....

.....

[4]

- (e) If one of the aqueous anions was a bromide, what would be the minimum evidence needed for its identification?

.....

.....

..... [1]

[Total: 16]

I	
II	
III	
IV	

BLANK PAGE

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

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
lead(II), Pb ²⁺ (aq)	white ppt. soluble in excess	white 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

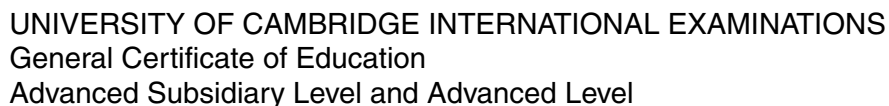
[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

<i>ion</i>	<i>reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), $\text{CrO}_4^{2-}(\text{aq})$	yellow solution turns orange with $\text{H}^+(\text{aq})$; gives yellow ppt. with $\text{Ba}^{2+}(\text{aq})$; gives bright yellow ppt. with $\text{Pb}^{2+}(\text{aq})$
chloride, $\text{Cl}^-(\text{aq})$	gives white ppt. with $\text{Ag}^+(\text{aq})$ (soluble in $\text{NH}_3(\text{aq})$); gives white ppt. with $\text{Pb}^{2+}(\text{aq})$
bromide, $\text{Br}^-(\text{aq})$	gives cream ppt. with $\text{Ag}^+(\text{aq})$ (partially soluble in $\text{NH}_3(\text{aq})$); gives white ppt. with $\text{Pb}^{2+}(\text{aq})$
iodide, $\text{I}^-(\text{aq})$	gives yellow ppt. with $\text{Ag}^+(\text{aq})$ (insoluble in $\text{NH}_3(\text{aq})$); gives yellow ppt. with $\text{Pb}^{2+}(\text{aq})$
nitrate, $\text{NO}_3^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil
nitrite, $\text{NO}_2^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil, NO liberated by dilute acids (colourless $\text{NO} \rightarrow$ (pale) brown NO_2 in air)
sulfate, $\text{SO}_4^{2-}(\text{aq})$	gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ or with $\text{Pb}^{2+}(\text{aq})$ (insoluble in excess dilute strong acids)
sulfite, $\text{SO}_3^{2-}(\text{aq})$	SO_2 liberated with dilute acids; gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (soluble in excess dilute strong acids)

3 Tests for gases

<i>gas</i>	<i>test and test result</i>
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 potassium dichromate(VI) (aq) from orange to green



--	--	--	--	--

--	--	--	--

9701/36

October/November 2011

2 hours

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

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 11 and 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.

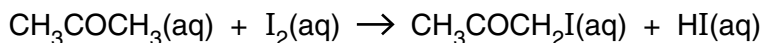
Session
Laboratory

For Examiner's Use	
1	
2	
Total	

This document consists of **11** printed pages and **1** blank page.

- 1 Iodine and propanone react together at room temperature in the presence of an acid catalyst.

For
Examiner's
Use



In the following experiment you will investigate how the rate of reaction alters when the concentration of a reagent is changed. When the reaction is complete, the solution turns colourless as all the iodine has been used up. It is possible to determine the rate of the reaction by measuring how long it takes for the mixture to go colourless.

The product of the reaction, $\text{CH}_3\text{COCH}_2\text{I}$, is a strong irritant to the eyes. Make sure that at the end of each experiment you wash out the reaction flask with plenty of water.

FB 1 is 2.0 mol dm^{-3} aqueous propanone, CH_3COCH_3 .

FB 2 is 3.0 mol dm^{-3} hydrochloric acid, HCl .

FB 3 is $0.0050 \text{ mol dm}^{-3}$ aqueous iodine, I_2 .

(a) Method

Read through the method and prepare a table for your results before starting any practical work.

Experiment 1

- Fill the burette labelled **FB 1** with the propanone solution, **FB 1**.
- Fill the second burette with distilled water.
- Run 20.0 cm^3 of **FB 1** into a 100 cm^3 beaker.
- Using a 25 cm^3 measuring cylinder, add 20 cm^3 of **FB 2** to the beaker.
- Using a second 25 cm^3 measuring cylinder, measure 10 cm^3 of **FB 3**.
- Add the measured **FB 3** to the solution in the 100 cm^3 beaker and start timing immediately.
- Stir the mixture once and place the beaker on a white tile.
- Stop timing as soon as the solution goes colourless. Record this reaction time to the **nearest second**.
- Wash out the beaker thoroughly.

Experiment 2

- Run 14.0 cm^3 of **FB 1** into the 100 cm^3 beaker.
- Run 6.0 cm^3 of distilled water into the 100 cm^3 beaker.
- Using the measuring cylinder, add 20 cm^3 of **FB 2** to the beaker.
- Using the second measuring cylinder, measure 10 cm^3 of **FB 3**.
- Add the measured **FB 3** to the solution in the 100 cm^3 beaker and start timing immediately.
- Stir the mixture once and place the beaker on a white tile.
- Stop timing as soon as the solution goes colourless and record the reaction time as before.
- Wash out the beaker thoroughly.

Experiment 3*For
Examiner's
Use*

Repeat the experiment as before using the volumes below.

- 8.0 cm³ of **FB 1**
- 12.0 cm³ of distilled water
- 20 cm³ of **FB 2**
- 10 cm³ of **FB 3**

Record all your results for experiments **1**, **2** and **3** in the space below showing the volume of propanone solution, **FB1**, the volume of distilled water and the reaction time.

[3]

- (b) Carry out two experiments to investigate further how the reaction time changes with different concentrations of propanone. Remember that the combined volume of propanone solution and distilled water must always be 20.0 cm³. Record these results in the space below.

[2]

- (c) (i) Calculate the number of moles of iodine that were added in each experiment.

..... mol

- (ii) Calculate the initial concentration of the iodine in 50 cm³ of the reaction mixture.

initial concentration of iodine = ... mol dm⁻³
[2]

- (d) The rate of the reaction can be represented by the following formula.

$$\text{'rate'} = \frac{\text{concentration of iodine from (c)(ii)}}{\text{reaction time}} \times 10^5$$

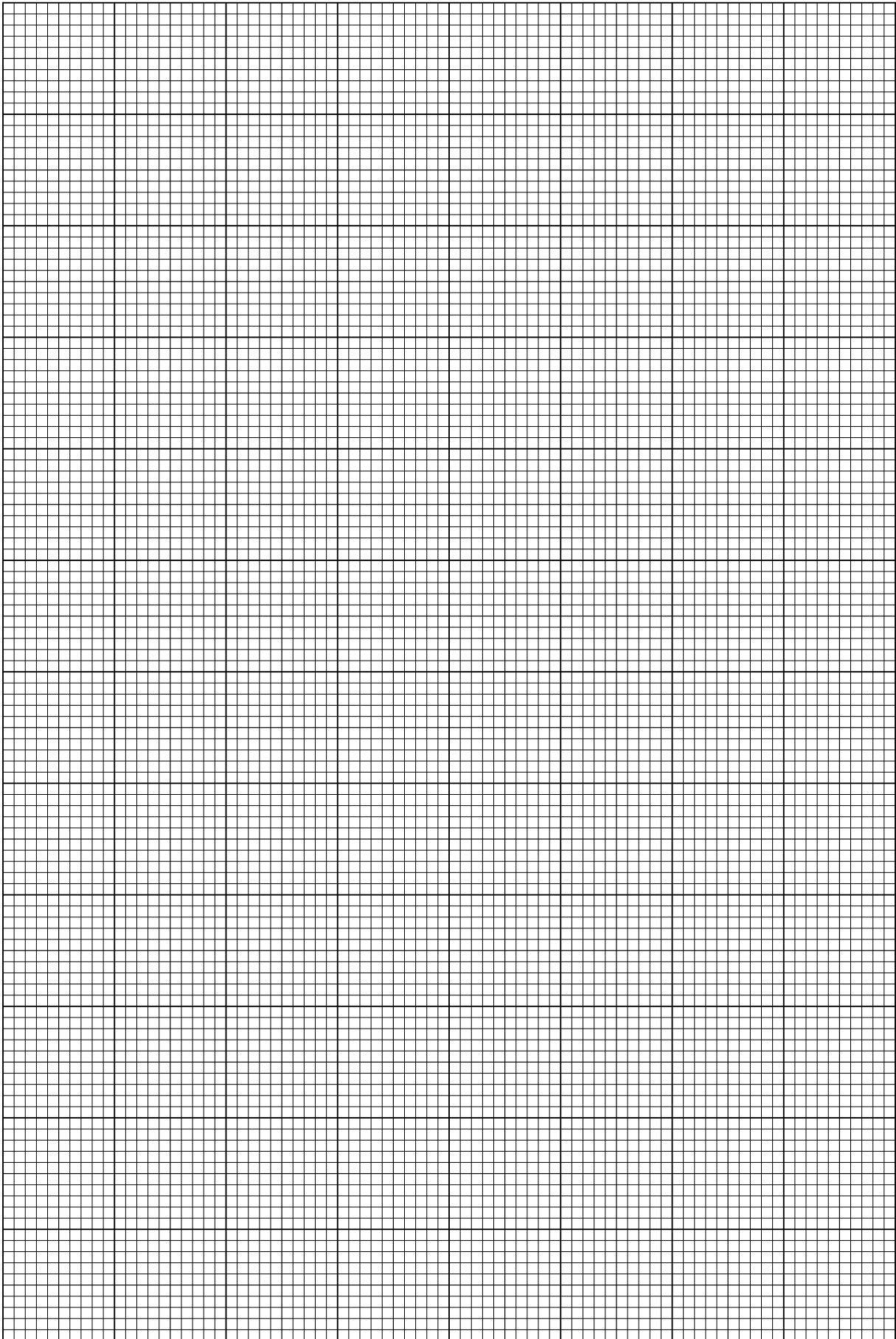
Use your experimental results to complete the following table to include the reaction time and the 'rate'.

volume of propanone solution, FB1 / cm ³		

[2]

- (e) On the grid opposite, plot the 'rate' against the volume of propanone solution, **FB1**. Draw a line of best fit through the points you have plotted.

For
Examiner's
Use



I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

- (f) (i) From your results what conclusion can you draw about the relationship between the rate of this reaction and the concentration of propanone?

.....

- (ii) Suggest an improvement to the experiment that would allow you to be more confident about this conclusion.

.....

[3]

- (g) Carry out **one** additional experiment to investigate how the 'rate' is altered when the concentration of **iodine** is halved. Record the volume of each solution used and the reaction time in the space below. Calculate the 'rate' using the equation in (d).

'rate' = ... [2]

- (h) From your results in (d) and (g), what conclusion can you draw about the relationship between the rate of reaction and the concentration of iodine?

.....
 [1]

- (i) In these experiments you used a burette to measure 20.0cm^3 of **FB 1**. Calculate the percentage error in measuring this volume.

percentage error = ... [2]

[Total: 25]

2 Qualitative Analysis

For
Examiner's
Use

At each stage in 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 full name or correct formula of the reagents must be given.

FB 4, FB 5 and **FB 6** are aqueous solutions each of which contains a single cation and a single anion. One of these solutions is a dilute acid and this is the only acid present. By carrying out specific tests you will identify all three compounds.

- (a) (i) Select a single chemical reagent which would allow you to identify the dilute acid. You may not use indicator paper.

reagent

- (ii) Use this reagent to test all three solutions and record your observations in an appropriate form in the space below.

- (iii) From your observations in (ii), identify which solution is the dilute acid.

FB is the dilute acid.

[4]

(b) The acid you have identified in (a)(iii) is dilute sulfuric acid.

Complete the following table.

For
Examiner's
Use

<i>test</i>	<i>observations</i>
To 1 cm depth of FB 4 in a test-tube, add 1 cm depth of FB 5 .	
To 1 cm depth of FB 5 in a test-tube, add 1 cm depth of FB 6 .	
To 1 cm depth of FB 6 in a test-tube, add 1 cm depth of FB 4 .	

[3]

(c) Test the two remaining unidentified solutions separately with aqueous sodium hydroxide and aqueous ammonia. Record your observations in a suitable form below. You are reminded that if any solution is warmed a boiling tube **MUST** be used.

[4]

- (d) From your observations in (a), (b) and (c), identify the ions present in the two solutions tested in (c), giving the relevant evidence for each. If you have not been able to identify one or more of the ions, explain why the evidence obtained was insufficient.

For
Examiner's
Use

FB cation evidence

.....

.....

..... anion evidence

.....

.....

FB cation evidence

.....

.....

..... anion evidence

.....

.....

[4]

[Total: 15]

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
lead(II), Pb ²⁺ (aq)	white ppt. soluble in excess	white 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

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

<i>ion</i>	<i>reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-} (aq)	yellow solution turns orange with H^+ (aq); gives yellow ppt. with Ba^{2+} (aq); gives bright yellow ppt. with Pb^{2+} (aq)
chloride, Cl^- (aq)	gives white ppt. with Ag^+ (aq) (soluble in NH_3 (aq)); gives white ppt. with Pb^{2+} (aq)
bromide, Br^- (aq)	gives cream ppt. with Ag^+ (aq) (partially soluble in NH_3 (aq)); gives white ppt. with Pb^{2+} (aq)
iodide, I^- (aq)	gives yellow ppt. with Ag^+ (aq) (insoluble in NH_3 (aq)); gives yellow ppt. with Pb^{2+} (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) or with Pb^{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

<i>gas</i>	<i>test and test result</i>
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 dichromate(VI) from orange to green

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.