

Cambridge International AS & A Level

Cambridge International Examinations

Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME						
CENTRE NUMBER				NDIDATE MBER		

CHEMISTRY 9701/35

Paper 3 Advanced Practical Skills 1

May/June 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 11 printed pages and 1 blank page.



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Sulfur forms the peroxodisulfate anion, $S_2O_8^{2-}$. This ion can oxidise iodide ions, I^- , to iodine, I_2 , as shown in the equation.

$$2I^{-}(aq) + S_2O_8^{2-}(aq) \rightarrow I_2(aq) + 2SO_4^{2-}(aq)$$

You will carry out a series of experiments to investigate how the rate of this reaction is affected by changing the concentration of the solutions.

The rate can be measured by adding thiosulfate ions, $S_2O_3^{2-}$, and starch indicator. As the reaction between $S_2O_8^{2-}$ and I^- occurs iodine is produced, but it reacts immediately with the thiosulfate.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^{-}(aq) + S_4O_6^{2-}(aq)$$

When all the thiosulfate has reacted, the iodine will remain in the mixture and cause the starch indicator to turn blue-black. The rate of reaction may be determined by timing how long it takes the reaction mixture to turn blue-black.

FA 1 is 0.0200 mol dm⁻³ potassium peroxodisulfate, K₂S₂O₈.

FA 2 is 1.00 mol dm⁻³ potassium iodide, KI.

FA 3 is $0.00500\,\mathrm{mol\,dm^{-3}}$ sodium thiosulfate, $\mathrm{Na_2S_2O_3}$.

starch indicator

Read through the instructions carefully and prepare a table for your results on page 4 before starting any practical work.

(a) Method

Experiment 1

- Fill the burette labelled FA 1 with FA 1.
- Use the pen to label one of the 100 cm³ beakers 'A' and the other 100 cm³ beaker 'B'.
- Run 20.00 cm³ of **FA 1** from the burette into beaker **A**.
- Use the measuring cylinder to add 20.0 cm³ of **FA 2** into beaker **B**.
- Use the measuring cylinder to add 10.0 cm³ of FA 3 to beaker B.
- Add 10 drops of starch indicator to beaker B.
- Add the contents of beaker A to beaker B and start timing immediately.
- Stir the mixture once and place the beaker on a white tile.
- Stop timing as soon as the solution turns blue-black.
- Record this reaction time to the nearest second in your results table.
- Wash out both beakers and shake to remove excess water.

Experiment 2

- Fill a second burette with distilled water.
- Run 10.00 cm³ of FA 1 into beaker A.
- Run 10.00 cm³ of distilled water into beaker A.
- Use the measuring cylinder to add 20.0 cm³ of FA 2 into beaker B.
- Use the measuring cylinder to add 10.0 cm³ of FA 3 to beaker B.
- Add 10 drops of starch indicator to beaker B.
- Add the contents of beaker A to beaker B and start timing immediately.
- Stir the mixture once and place the beaker on a white tile.
- Stop timing as soon as the solution turns blue-black.
- Record this reaction time to the nearest second in your results table.
- Wash out both beakers and shake to remove excess water.

Experiments 3-5

Carry out three further experiments to investigate how the reaction time changes with different volumes of potassium peroxodisulfate, FA 1.
 Note that the combined volume of FA 1 and distilled water must always be 20.00 cm³.
 Do not use a volume of FA 1 that is less than 6.00 cm³.

Keep FA 1, FA 2, FA 3 and the starch indicator for use in (e).

Calculating the rate of the reaction

The rate of the reaction can be represented by the formula shown.

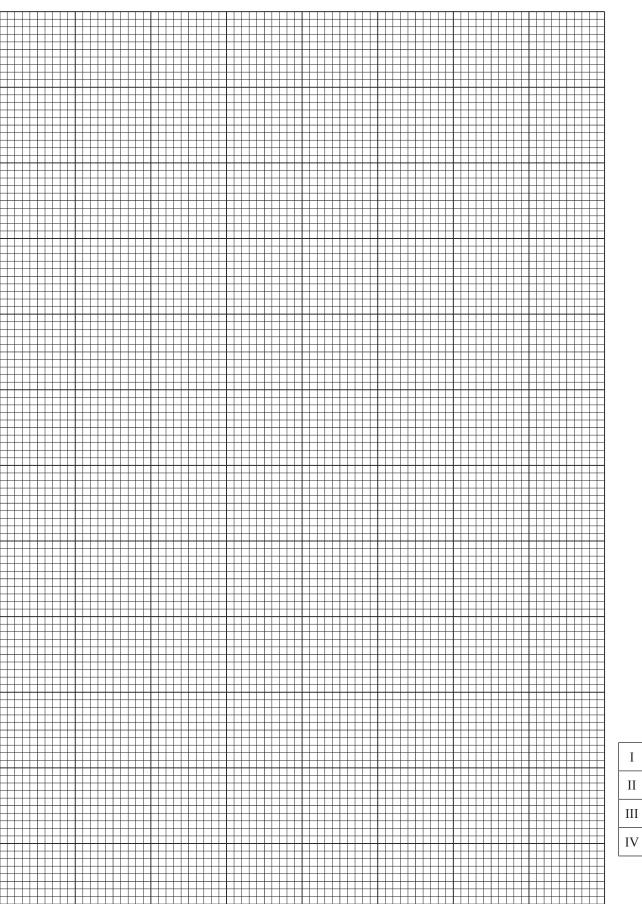
$$rate = \frac{500}{reaction time in seconds}$$

Use this formula to calculate the rate for each of your five experiments.

Record all your results in a single table. You should include the volume of **FA 1**, the volume of distilled water, the reaction time and the reaction rate for each of your five experiments.

[10]

(b) On the grid on page 5, plot the rate (*y*-axis) against the volume of **FA 1** (*x*-axis). Include the origin in your plot. Draw a straight line of best fit and circle any clearly anomalous points.





[4]

(c)	The	e volume of FA 1 is directly related to the concentration of potassium peroxodisulfate.
		m your results, what can be stated about the relationship between the rate of reaction and concentration of potassium peroxodisulfate?
		[1]
(d)	(i)	Use your graph to calculate the reaction time you would expect to measure if you carried out an experiment using 5.00 cm³ of FA 1 . Show your working.
		reaction time =s
	(ii)	Assume that the error in the time measured for each reaction was $\pm 0.5s$ in total. Calculate the maximum percentage error in the reaction time you measured in Experiment 1 . Show your working.
		maximum percentage error = %
((iii)	A student suggested that this error could be reduced if $0.0100\mathrm{moldm^{-3}}$ sodium thiosulfate were used in place of FA 3 .
		Do you agree with this student? Explain your answer.
((iv)	A student repeated Experiment 1 but used 0.100 mol dm ⁻³ sodium thiosulfate in place of FA 3 . The student found that the reaction mixture never turned blue-black.
		Explain why.
		[5]

	I
(e) (i)	Using the same method as in (a), carry out an additional experiment to record the reaction time to the nearest second when the following solutions are mixed together.
	 10.00 cm³ of FA 1 20.0 cm³ of FA 2 5.0 cm³ of FA 3 15.00 cm³ of distilled water 10 drops of starch indicator
	reaction time =
(ii)	Use your answer to (i) to estimate the reaction time that would be measured if the following solutions were mixed together.
	DO NOT CARRY OUT THIS EXPERIMENT
	 10.00 cm³ of FA 1 20.0 cm³ of FA 2 20.0 cm³ of FA 3 10 drops of starch indicator
	Explain your answer.
	estimated reaction time =

[Total: 24]

[4]

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) FA 4 and FA 5 are aqueous solutions. Each solution contains two different cations and the sulfate anion.
 - (i) Carry out the following tests and record your observations.

toot	observ	vations
test	FA 4	FA 5
To a 1 cm depth of solution in a boiling tube, add aqueous sodium hydroxide, then		
warm the tube carefully.		
To a 1 cm depth of solution in a test-tube, add aqueous ammonia.		

(ii)	Identify as many as possible of the cations in FA 4 and FA 5 .
	FA 4 contains the cation(s)
	FA 5 contains the cation(s)

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(b)	FA 6 is a salt	containing	either the	sulfate	anion	or sulfite	anion.	You w	ill first	make	a s	solution
-	of FA 6 .											

- Rinse one of the 100 cm³ beakers with distilled water.
- Place all the sample of **FA 6** into the beaker and add approximately 40 cm³ of distilled water.
- Stir the mixture until the solid has dissolved.

Select reagent(s) and carry	out tests to identify	the anion in FA 6.	Record your	results in the
space below.				

The formula of the anion in FA 6 is	[3	3]	
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- (c) FA 7 is a solution containing one cation and the sulfate anion.
 FA 8 is a solution containing the sodium cation and one of the anions from those listed in the Qualitative Analysis Notes.
 - (i) Carry out the following tests to determine the formulae of FA 7 and FA 8.

test	observations
To a 2 cm depth of FA 7 in a test-tube, add a 2 cm strip of magnesium.	
To a 1 cm depth of FA 7 in a test-tube add a 1 cm depth of FA 8 and shake the tube.	

(ii)	The formula of FA 7 is
	The formula of FA 8 is
iii)	Give the ionic equation for the reaction that takes place when magnesium is added to FA 7 . Include state symbols.
	[6]

[Total: 16]

Qualitative Analysis Notes

1 Reactions of aqueous cations

ion	reaction 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, NH₄⁺(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), Cr³+(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), Fe³+(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), 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)	NH₃ 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)	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

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18	2	He	heliun 4.0	10	Ne	neon 20.2	18	Ā	argor 39.9	36	궃	krypto. 83.8	72	×e	xenor 131.3	86	R	rador			
17				6	Щ	fluorine 19.0	17	Cl	chlorine 35.5	35	Ā	bromine 79.9	53	П	iodine 126.9	82	¥	astatine -			
16				00	0	oxygen 16.0	16	S	sulfur 32.1	34	Se	selenium 79.0	52	<u>e</u>	tellurium 127.6	84	Ъ	polonium –	116	^	livermorium -
15				7	z	nitrogen 14.0	15	۵	phosphorus 31.0	33	As	arsenic 74.9	51	Sb	antimony 121.8	83	Ξ	bismuth 209.0			
14				9	ပ	carbon 12.0	14	S	silicon 28.1	32	Ge	germanium 72.6	90	Sn	tin 118.7	82	Pb	lead 207.2	114	Εl	flerovium -
13				5	Ф	boron 10.8	13	Ρl	aluminium 27.0	31	Ga	gallium 69.7	49	In	indium 114.8	81	<i>1</i> L	thallium 204.4			
									12	30	Zn	zinc 65.4	48	පි	cadmium 112.4	80	å	mercury 200.6	112	ပ်	copernicium
									7	29	Cn	copper 63.5	47	Ag	silver 107.9	62	Αu	gold 197.0	111	Rg	roentgenium -
									10	28	z	nickel 58.7	46	Pd	palladium 106.4	78	చ	platinum 195.1	110	Ds	darmstadtium -
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					loc	SS			9	24	ပ်	chromium 52.0	42	Mo	molybdenum 95.9	74	≥	tungsten 183.8	106	Sg	seaborgium -
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						atol	ato	rela			4	22	F	titanium 47.9	40	Zr	zirconium 91.2	72	Ξ	hafnium 178.5	104
							_		ဇ	21	Sc	scandium 45.0	39	>	yttrium 88.9	57-71	lanthanoids		89-103	actinoids	
2				4	Be	beryllium 9.0	12	Mg	magnesium 24.3	20	Ca	calcium 40.1	38	Š	strontium 87.6	56	Ba	barium 137.3	88	Ra	radium -
_				က	=	lithium 6.9	7	Na	sodium 23.0	19	×	potassium 39.1	37	Rb	rubidium 85.5	55	S	caesium 132.9	87	ъ.	francium -
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Lu Lu	lutetium 175.0	103	۲	lawrencium -	
oz Yb	ytterbium 173.1	102	Š	nobelium	
ee Tm	thulium 168.9	101	Md	mendelevium -	
₈₈ 正	erbium 167.3	100	Fm	fermium -	
67 Ho	holmium 164.9	66	Es	einsteinium -	
ee Dy	dysprosium 162.5	86	ర్	californium	
e5 Tb	terbium 158.9	26	Ř	berkelium	
² Gd	gadolinium 157.3	96	CH	curium	
63 Eu	europium 152.0	92	Am	americium	
ss Sm	samarium 150.4	94	Pn	plutonium	
Pm	promethium -	93	ď	neptunium	
9 9 8	neodymium 144.4	92	\supset	uranium 238.0	
₅₉	praseodymium 140.9	91	Ра	protactinium 231.0	
Se Ce	cerium 140.1	06	Т	thorium 232.0	
57 La	lanthanum 138.9	88	Ac	actinium -	

lanthanoids

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