

Cambridge International Examinations

Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME		
CENTRE NUMBER	CANDIDATE NUMBER	

CHEMISTRY

Paper 3 Advanced Practical Skills 2

October/November 2018

2 hours

9701/36

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 14 and 15.

A copy of the Periodic Table is printed on page 16.

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 14 printed pages and 2 blank pages.



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 Iron(III) ions oxidise iodide ions, I^- , to iodine, I_2 .

$$2Fe^{3+}(aq) + 2I^{-}(aq) \rightarrow 2Fe^{2+}(aq) + I_{2}(aq)$$

In this experiment you will investigate how the rate of this reaction is affected by the concentration of Fe^{3+} ions. To do this you will add thiosulfate ions, $S_2O_3^{2-}$, and starch indicator to a mixture of Fe^{3+} (aq) and I^- (aq). The iodine produced by the reaction reacts immediately with the thiosulfate ions and is reduced back to iodide.

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

When all the thiosulfate has reacted, the iodine remaining in solution turns the starch indicator blue-black. The rate of reaction can be determined by timing how long it takes for the reaction mixture to turn blue-black.

FB 1 is $0.0500 \,\text{mol dm}^{-3}$ acidified iron(III) chloride, FeC l_3 .

FB 2 is 0.0500 mol dm⁻³ potassium iodide, KI.

FB 3 is 0.00500 mol dm⁻³ sodium thiosulfate, Na₂S₂O₃.

FB 4 is starch indicator.

(a) Method

Experiment 1

- Fill the burette labelled FB 1 with FB 1.
- Run 20.00 cm³ of **FB 1** into a 100 cm³ beaker.
- Using the measuring cylinder add the following to the second 100 cm³ beaker:
 - o 10 cm³ of **FB 2**
 - o 20 cm³ of **FB 3**
 - 10 cm³ of FB 4
- Add the contents of the first beaker to the second beaker 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. Ignore any colour changes that occur before the intense blue-black colouration.
- Record this reaction time to the nearest second in the space provided on page 4.
- Rinse both beakers and shake dry. Rinse and dry the glass rod.

Experiment 2

- Fill a second burette with distilled water.
- Run 10.00 cm³ of FB 1 into a 100 cm³ beaker.
- Run 10.00 cm³ of distilled water into the same beaker containing **FB 1**.
- Using the measuring cylinder add the following to the second 100 cm³ beaker:
 - 10 cm³ of **FB 2**
 - o 20 cm³ of **FB 3**
 - o 10 cm³ of **FB 4**
- Add the contents of the first beaker to the second beaker 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. Ignore any colour changes that occur before the intense blue-black colouration.
- Record this reaction time to the nearest second in the space provided on page 4.
- Rinse both beakers and shake dry. Rinse and dry the glass rod.

Experiments 3-5

• Carry out three further experiments to investigate how the reaction time changes with different volumes of **FB 1**.

Remember that the combined volume of **FB 1** and distilled water must always be 20.00 cm³. Do **not** carry out an experiment using 15.00 cm³ of **FB 1**.

Do **not** use a volume of **FB 1** that is less than 5.00 cm³.

Keep all FB labelled solutions for use in (e) and in Question 2.

Record all your results in a single table. You should include the volume of **FB 1**, the volume of distilled water and the reaction time.

The relative rate for the reaction is given by the following expression.

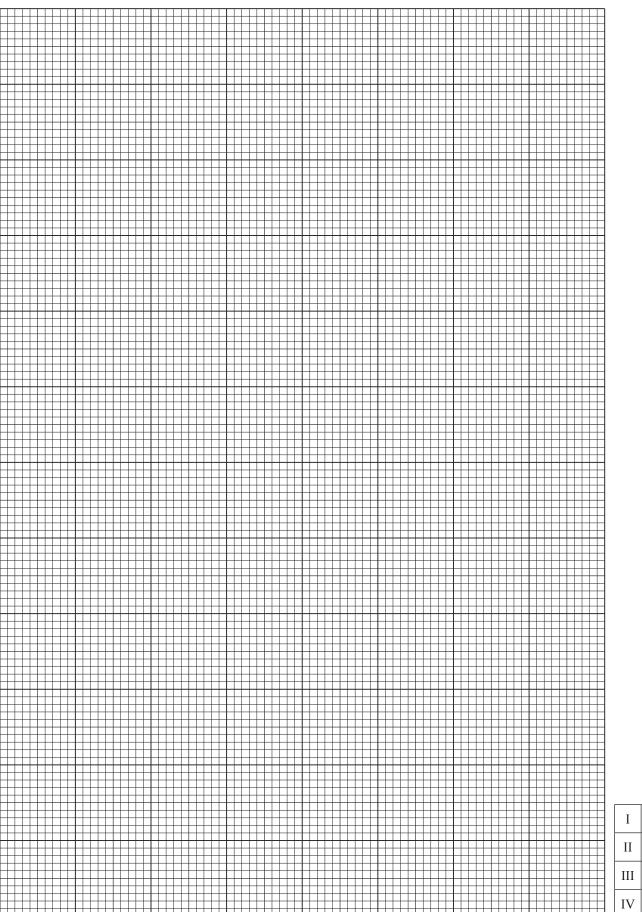
relative rate =
$$\frac{1000}{\text{reaction time in seconds}}$$

Use this expression to calculate the relative rate for each of your experiments and record the values in your results table.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	
IX	
X	

[10]

(b) On the grid opposite, plot the relative rate against the volume of **FB 1**. Include the origin in your plot. Label any points you consider anomalous. Draw a line of best fit.



I II III IV

[4]

(c)		m your graph, what conclusion can you make about the relationship between the relative for the reaction and the volume of FB 1 used? Explain your answer.
		[2]
(d)		tudent carried out the same experiment but used 15.00 cm ³ of FB 1 . The student recorded alue for the reaction time of 28 s.
	(i)	Use your graph to calculate the time you would have expected to record if you had carried out an experiment using 15.00 cm ³ of FB 1 . Show the construction lines on your graph and show your working in the calculation.
		reaction time = s [2]
	(ii)	Calculate the percentage difference between your value and that of the student. Show your working.
		percentage difference = % [1]
(e)	and	are to carry out a sixth experiment. The concentrations of iron(III) chloride, sodium thiosulfated starch indicator should all be the same as in <i>Experiment 2</i> but the concentration of iodides should be twice the value that it is in <i>Experiment 2</i> .

State the volume of each solution used and record the reaction time to the nearest second.

[2]

(i)	$20.00\mathrm{cm^3}$ of $0.0500\mathrm{moldm^{-3}}$ FeC l_3 , FB 1 , were reacted with excess KI, FB 2 .
	Using the information on page 2, calculate the number of moles of ${\rm I_2}$ produced.
	$moles\; \mathrm{I_2} = \ldots \ldots mol \;\; [2]$
(ii)	The iodine produced in (i) required 35.00 cm³ of a different solution of sodium thiosulfate for complete reaction.
	Calculate the concentration of the solution of sodium thiosulfate used.
	concentration of $Na_2S_2O_3 = \dots mol dm^{-3}$ [1]
	[Total: 24]
	(ii)

Qualitative Analysis

Where reagents are selected for use in a test, the **full 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.

- 2 (a) FB 1 is aqueous acidified iron(III) chloride, FeC l_3 . FB 5 is 0.150 mol dm⁻³ sodium thiosulfate, Na₂S₂O₃.
 - (i) Carry out the following tests and record your observations.

test	observations
To a 1 cm depth of FB 1 in a test-tube add a 1 cm depth of FB 5 . Leave to stand until there is no further change, then	
add aqueous sodium hydroxide.	
To a 1 cm depth of FB 5 in a test-tube add a few drops of dilute hydrochloric acid.	
Leave to stand.	
Rinse the tube thoroughly.	

*	9
In (i) you should have observed a read	ction between Fe³+(aq) and S₂O₃²-(aq).
Do you think that this reaction affected on page 2. Explain your answer.	your results in Question 1 ? Refer to the equations
	[1]
6 is a solution containing a halide ion.	
Carry out the following tests and recor	rd your observations.
test	observations
a 1 cm depth of FB 6 in a test-tube dd aqueous silver nitrate, then	
dd aqueous ammonia.	
a 1 cm depth of FB 6 in a test-tube dd aqueous silver nitrate, then	
dd FB 5 .	
	[2
The halide in FB 6 is	[1]
	In (i) you should have observed a real Do you think that this reaction affected on page 2. Explain your answer. 6 is a solution containing a halide ion. Carry out the following tests and recontaining a 1 cm depth of FB 6 in a test-tube did aqueous silver nitrate, then did aqueous ammonia.

(c) FB 7 is a solution of copper(II) sulfate, Cu

,	:\	C = rm /	aut tha	fallowing	40040	and "aaa"		abaam/atiana
(1)	Cally	out the	IOIIOWIIIQ	เยรเร	and record	ı your	observations.

test	observations
To a 1cm depth of FB 7 in a test-tube add a 1cm depth of FB 2 , KI, then	
add FB 4 , starch indicator.	
To a 1 cm depth of FB 7 in a test-tube add a 1 cm depth of FB 5 , then	
add a 1 cm depth of FB 2 followed by FB 4 , starch indicator.	
	[3]
(ii) Give the formula of one of the product	es formed in the reaction of FB 7 with FB 2 in the first

[1]

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test.

(d)	FB 8	B is	a solution	on of	a sa	t containing	one	cation	and	one	anion	from	those	listed	in	the
	Qua	litativ	e Analy	sis N	otes.											
					_											

The cation in **FB 8** is one of Mg²⁺, Zn²⁺ or A l^{3+} . The anion in **FB 8** is either SO₃²⁻ or SO₄²⁻.

(i) Select reagents and carry out tests to identify which ions are present in **FB 8**. Give details of your tests and observations.

[4]

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Qualitative Analysis Notes

1 Reactions of aqueous cations

ion	reaction with									
ion	NaOH(aq)	NH ₃ (aq)								
aluminium, Al³+(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, Mg²+(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess								
manganese(II), Mn²+(aq)	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess								
zinc, Zn²+(aq)	white ppt. soluble in excess	white ppt. soluble in excess								

2 Reactions of anions

ion	reaction
carbonate, CO ₃ ²⁻	CO ₂ liberated by dilute acids
chloride, C <i>l</i> ⁻ (aq)	gives white ppt. with Ag ⁺ (aq) (soluble in NH ₃ (aq))
bromide, Br ⁻ (aq)	gives cream ppt. with Ag ⁺ (aq) (partially soluble in NH ₃ (aq))
iodide, I ⁻ (aq)	gives yellow ppt. with Ag ⁺ (aq) (insoluble in NH ₃ (aq))
nitrate, NO ₃ ⁻ (aq)	NH ₃ liberated on heating with OH ⁻ (aq) and A <i>l</i> foil
nitrite, NO ₂ ⁻ (aq)	NH ₃ liberated on heating with OH ⁻ (aq) and A <i>l</i> 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

	18	٥.	ъ	E O	0	Ф	neon 20.2	8	>	argon 39.9	9	٦	oton 1.8	4	<u>.</u> Ф.	1.3	9	<u>د</u>	radon -			
	_		エ	hel 4.	-	Z	20 20	-	_	arç 39	8		kryf 833	2	× _	xer 13:	80	<u>~</u>	rac			
	17				6	ш	fluorine 19.0	17	Cl	chlorine 35.5	35	Ŗ	bromine 79.9	53	Н	iodine 126.9	82	Αţ	astatine -			
	16				8	0	oxygen 16.0	16	ഗ	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	<u>.</u>	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	Zu	zinc 65.4	48	පි	cadmium 112.4	80	Я	mercury 200.6	112	ပ်	copernicium
										7	29	Cn	copper 63.5	47	Ag	silver 107.9	62	Au	gold 197.0	111	Rg	roentgenium -
dn										10	28	z	nickel 58.7	46	Pd	palladium 106.4	78	చ	platinum 195.1	110	Ds	darmstadtium -
Group										6	27	රි	cobalt 58.9	45	뫈	rhodium 102.9	77	٦	iridium 192.2	109	¥	meitnerium -
		_	I	hydrogen 1.0						80	26	Ьe	iron 55.8	44	Ru	ruthenium 101.1	9/	SO	osmium 190.2	108	ΗS	hassium
					J					7	25	Mn	manganese 54.9	43	ည	technetium -	75	Re	rhenium 186.2	107	ВР	bohrium
						loc	SS			9	24	ပ်	chromium 52.0	42	Mo	molybdenum 95.9	74	≯	tungsten 183.8	106	Sg	seaborgium -
				Key	atomic number	atomic symbo	name relative atomic mass			2	23	>	vanadium 50.9	41	qN	niobium 92.9	73	Щ	tantalum 180.9	105	<u>ө</u>	dubnium -
						ato	rela			4	22	F	titanium 47.9	40	Zr	zirconium 91.2	72	Ξ	hafnium 178.5	104	¥	rutherfordium -
								_		က	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
	_				3	:=	lithium 6.9	7	Na	sodium 23.0	19	×	potassium 39.1	37	Rb	rubidium 85.5	55	S	caesium 132.9	87	Ļ	francium -

Lu	lutetium 175.0	103	۲	lawrencium	ı
Vb	ytterbium 173.1	102	8 N	nobelium	ı
m T	thulium 168.9	101	Md	mendelevium	ı
68 F	erbium 167.3	100	Fm	fermium	ı
67 H0	holmium 164.9	66	Es	einsteinium	ı
66 Dy	dysprosium 162.5	86	Ç	californium	I
65 Tb	terbium 158.9	26	益	berkelium	ı
² DO	gadolinium 157.3	96	Cm	curium	ı
63 Eu	europium 152.0	98	Am	americium	I
62 Sm	samarium 150.4	94	Pn	plutonium	ı
Pm	promethium	93	ď	neptunium	ı
9 09	neodymium 144.4	92	\supset	uranium	238.0
59 P	praseodymium 140.9	91	Ра	protactinium	231.0
S8 Ce	cerium 140.1	06	Th	thorium	232.0
57 La	lanthanum 138.9	88	Ac	actinium	ı

lanthanoids

actinoids

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