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CAMBRIDGE
International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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* 9 3 2 3 3 8 7 9 8 3 *

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **May/June 2026**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.
- Important values, constants and standards are printed in the question paper.
- Notes for use in qualitative analysis are provided in the question paper.

Session
Laboratory

For Examiner's Use	
1	
2	
3	
Total	

This document has **12** pages. Any blank pages are indicated.

DC (CE) 350751/3

[Turn over

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 the precision of the apparatus you used in the data you record.

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

1 In this experiment, you will carry out a titration to determine the concentration of a solution of sodium thiosulfate, $Na_2S_2O_3$.

You will first react iodate(V) ions, IO_3^-, with an excess of iodide ions, I^-, to produce a known amount of iodine, I_2. This iodine is then titrated with the solution of sodium thiosulfate of unknown concentration.

FB 1 is aqueous sodium thiosulfate, $Na_2S_2O_3$, of unknown concentration.
FB 2 is aqueous potassium iodate(V) containing 3.35 g dm^{-3} KIO_3.
FB 3 is dilute sulfuric acid, H_2SO_4.
FB 4 is 0.500 mol dm^{-3} potassium iodide, KI.
FB 5 is starch indicator.

(a) Method

- Fill the burette with **FB 1**.
- Pipette 25.0 cm^3 of **FB 2** into a conical flask.
- Use the measuring cylinder to add 10.0 cm^3 of **FB 3** to the conical flask.
- Use the same measuring cylinder to add 10.0 cm^3 of **FB 4** to the conical flask.
- Add **FB 1** from the burette until the solution turns yellow.
- Add 10–15 drops of **FB 5** to the solution in the conical flask until the mixture turns blue-black.
- Continue to add more **FB 1** from the burette until the mixture just becomes colourless.
- Perform a rough titration and record your burette readings.
- Discard the contents of the conical flask **immediately**. Rinse the conical flask with water.

rough titre = ... cm^3

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Discard the contents of the conical flask **immediately** after each titration. Rinse the conical flask with water.
- Make sure any recorded results show the precision of your practical work.
- Record in a suitable form all your burette readings and the volume of **FB 1** added in each accurate titration.

Keep the remaining FB 1 for use in Question 3.

Results

I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, calculate a suitable mean value to use in your calculations. Show clearly how you obtain the mean value.

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

(c) Calculations

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

(ii) Calculate the amount, in mol, of IO_3^- ions in 25.0 cm^3 of **FB 2**.

amount of IO_3^- = ... mol [2]

(iii) The equations for the production of iodine and the titration of this iodine with thiosulfate ions are shown.

$$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$$

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

Use these equations to calculate the amount, in mol, of thiosulfate ions in the volume of **FB 1** in **1(b)**.

amount of $S_2O_3^{2-}$ = ... mol [1]

(iv) Calculate the concentration, in $mol\,dm^{-3}$, of sodium thiosulfate in **FB 1**.

concentration of $Na_2S_2O_3$ = ... $mol\,dm^{-3}$ [1]

[Total: 13]

2 You will carry out experiments using the hydrated salt $\mathbf{MX_2}$•$2H_2O$ and analyse the results to identify **M** and **X**.

M is the cation of a Group 2 metal.
X is the anion of an element in Group 17.

When $\mathbf{MX_2}$•$2H_2O$ is heated, the loss of mass is caused **only** by the water of crystallisation evaporating.

FB 6 is the hydrated salt, $\mathbf{MX_2}$•$2H_2O$.

(a) Method

(i) Thermal decomposition

- Weigh the empty crucible with its lid. Record the mass in the results section.
- Transfer all the **FB 6** from the container into the crucible.
- Weigh the crucible, lid and **FB 6**. Record the mass.
- Place the crucible, lid and contents on the pipeclay triangle.
- Heat the crucible gently, with the lid on, for approximately 1 minute.
- Heat the crucible strongly, with the lid off, for approximately 5 minutes.
- Replace the lid and leave the crucible to cool for at least 5 minutes.

During the cooling period, you may wish to begin work on Question 3.

- When the crucible is cool, weigh the crucible with its lid and contents. Record the mass.
- Calculate the mass of **FB 6** added to the crucible, the mass of the residue obtained and the mass loss. Record these masses.

Results

I	
II	
III	
IV	

[4]

(ii) Anion test

- Use a small amount of your residue from **2(a)(i)** to carry out a test to identify anion **X**. Describe how you carry out your test.
- Record your observations and conclusion.

anion **X** ....

[3]

(b) Calculations

(i) Calculate the amount, in mol, of water lost during the thermal decomposition.

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

(ii) Use your answers to **2(a)(i)** and **2(b)(i)** to calculate the relative formula mass, M_r, of $\mathbf{MX_2}$.

M_r of $\mathbf{MX_2}$ = ... [1]

(iii) Use your answers to **2(a)(ii)** and **2(b)(ii)** to calculate the atomic mass, A_r, of **M**. Identify cation **M**.

A_r of **M** = ...

cation **M** ....
[1]

(c) (i) Calculate the percentage error in the value for the M_r of $\mathbf{MX_2}$ that you calculated in **2(b)(ii)** compared to the actual value for the M_r of $\mathbf{MX_2}$.
Show your working.

percentage error = ... % [1]

(ii) Suggest an improvement to the method given in **2(a)(i)** to reduce the percentage error in the value of M_r calculated.

....

....

.... [1]

[Total: 12]

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Qualitative analysis

For each test, you should record all your observations in the spaces provided.

Examples of observations include:

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

You should record clearly at what stage in a test an observation is made.

Where no change is observed, you should write 'no change'.

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

If any solution is warmed, a boiling tube must be used. If a solid is heated, a hard-glass test-tube must be used.

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

No additional tests should be attempted.

3 **(a)** **(i)** **FB 7** is solid potassium manganate(VII).

Transfer a small spatula measure of **FB 7** into a hard-glass test-tube. Heat the test-tube gently at first, and then more strongly.

Record your observations. Identify the gas produced.

....

....

....

gas produced ....

[2]

(ii) The reaction that occurs in **3(a)(i)** is a redox reaction.
Explain why this reaction is a redox reaction by referring to one or more of the elements in **FB 7**.

....

.... [1]

(b) **FB 8** is a solution containing one cation and two anions.
FB 9 is a solution containing one cation and one anion.
All the anions are listed in the Qualitative analysis notes.

(i) Carry out the following tests and record your observations in Table 3.1.
Use a 1 cm depth of **FB 8** or **FB 9** in a test-tube for each test.

Table 3.1

test	observations	
	FB 8	**FB 9**
Test 1 Add acidified aqueous potassium manganate(VII) dropwise.		
Test 2 Add a 1 cm strip of magnesium ribbon.		
Test 3 Add aqueous barium chloride or aqueous barium nitrate.		
Test 4 Add a 1 cm depth of **FB 1**, aqueous sodium thiosulfate. Leave to stand for 1 minute. **Immediately after the test, empty and thoroughly rinse the test-tube.**		

[5]

DO NOT WRITE IN THIS MARGIN

(ii) Carry out tests to identify the cation in **FB 8**.
Record your tests and observations in a suitable form.

You **must** use a boiling tube if any liquid is heated.

[3]

(iii) Use your observations in **3(b)(i)** and **3(b)(ii)** to identify the ions present in **FB 8**. If you **cannot** positively identify an ion or ions, write 'unknown'.

cation in **FB 8** ....

anions in **FB 8** .... and ....
[2]

(iv) Deduce the formula of **FB 9**.

FB 9 .... [1]

(v) Write an ionic equation for **one** reaction in **3(b)(i)** involving **FB 9**.
Include state symbols.

.... [1]

[Total: 15]

Qualitative analysis notes

Reactions of cations

cation	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 warming	–
barium, Ba^{2+}(aq)	faint white ppt. is observed unless [Ba^{2+}(aq)] is very low	no ppt.
calcium, Ca^{2+}(aq)	white ppt. unless [Ca^{2+}(aq)] is very low	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	pale 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

Reactions of anions

anion	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 / off-white ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^-(aq)	gives pale 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; decolourises acidified aqueous $KMnO_4$
sulfate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) (insoluble in excess dilute strong acids); gives white ppt. with high [Ca^{2+}(aq)]
sulfite, SO_3^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acids); decolourises acidified aqueous $KMnO_4$
thiosulfate, $S_2O_3^{2-}$(aq)	gives off-white / pale yellow ppt. slowly with H^+

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
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint

Tests for elements

element	test and test result
iodine, I_2	gives blue-black colour on addition of starch solution

Important values, constants and standards

molar gas constant	$R = 8.31\,\text{J}\,\text{K}^{-1}\,\text{mol}^{-1}$
Faraday constant	$F = 9.65 \times 10^4\,\text{C}\,\text{mol}^{-1}$
Avogadro constant	$L = 6.022 \times 10^{23}\,\text{mol}^{-1}$
electronic charge	$e = -1.60 \times 10^{-19}\,\text{C}$
molar volume of gas	$V_m = 22.4\,\text{dm}^3\,\text{mol}^{-1}$ at s.t.p. (101 kPa and 273 K) $V_m = 24.0\,\text{dm}^3\,\text{mol}^{-1}$ at room conditions
ionic product of water	$K_w = 1.00 \times 10^{-14}\,\text{mol}^2\,\text{dm}^{-6}$ (at 298 K (25 °C))
specific heat capacity of water	$c = 4.18\,\text{kJ}\,\text{kg}^{-1}\,\text{K}^{-1}$ ($4.18\,\text{J}\,\text{g}^{-1}\,\text{K}^{-1}$)

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	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 –