VICTORIA JUNIOR COLLEGE
PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME ……..

CT GROUP ……..

CHEMISTRY 9729/04

Paper 4 Practical **29 Aug 2022**

Candidates answer on the Question Paper. **2 hours 30 minutes**

Additional Materials: As listed in the instructions below

READ THESE INSTRUCTIONS FIRST

Write your name and CT group on all the work you hand in.
Give details of the practical shift and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.
Qualitative Analysis Notes are printed on pages 13 and 14.

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.

Shift
Laboratory

For Examiner's Use	
1	**/ 9**
2	**/ 12**
3	**/ 11**
4	**/ 15**
5	**/ 8**
Total	**/ 55**

This document consists of **14** printed pages.

Answer **all** the questions in the spaces provided.

1 In acidic solutions, iron(III) ions are reduced by iodide ions to form iron(II) ions. The iodide ions are oxidised to iodine.

$$2Fe^{3+}(aq) + 2I^{-}(aq) \rightarrow 2Fe^{2+}(aq) + I_2(aq)$$

The rate of this reaction can be investigated by using starch indicator, which turns blue-black in the presence of iodine. Sodium thiosulfate is added to the reaction mixture to react with iodine as it is formed. The blue-black colour is seen when all the thiosulfate has reacted.

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

You will investigate how the rate of reaction is affected by changing the concentration of the iodide ions.

FA 1 is 0.050 mol dm^{-3} potassium iodide, KI.
FA 2 is 0.050 mol dm^{-3} acidified iron(III) chloride, $FeCl_3$.
FA 3 is 0.0050 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
FA 4 is starch indicator.

(a) Experiment 1

1. Use the burette **labelled FA 1** to transfer 10.00 cm^3 of **FA 1** into a 250 cm^3 conical flask.
2. Use a 25 cm^3 measuring cylinder to transfer 10.0 cm^3 of deionised water into the conical flask.
3. Use the burette **labelled FA 3** to transfer 20.00 cm^3 of **FA 3** and a 50 cm^3 measuring cylinder to transfer 10 cm^3 of **FA 4** to the same conical flask.
4. Use a 10 cm^3 measuring cylinder to measure 10 cm^3 of **FA 2**.
5. Add this **FA 2** into the same conical flask and start timing immediately.
6. Swirl the mixture once and place the conical flask on the white tile.
7. Stop timing as soon as the solution turns **intense** blue-black.
8. Record the time taken, ***t***, to the nearest second.
9. Wash out the conical flask and stand it upside down in a beaker to drain for use again.

Experiment 2

10. Repeat Experiment 1 but use 20.00 cm^3 of **FA 1** instead of 10.00 cm^3 in step 1 and use 0.0 cm^3 of deionised water instead of 10.0 cm^3 in step 2.

Experiments 3 to 5

11. Carry out **three** further experiments to investigate how the reaction time changes with different volumes of potassium iodide, **FA 1**.
    The combined volume of **FA 1** and deionised water must always be 20 cm^3.
    Do not use a volume of **FA 1** that is less than 6 cm^3.

In the space on the next page, prepare a table to record the following for each of the five experiments.

- ***V*,** Volume of **FA 1** used,
- Volume of water used,
- ***t***, Reaction time, to the nearest second,
- ***Vt***,
- V^2t

Keep solutions FA 1, FA 3 and FA 4 for use in Question 2.

Results

Experiment	*V*, Volume of FA 1 / cm^3	Volume of water / cm^3	*t*, Reaction time / s	*Vt*	V^2t
1	10.00	10.0	120	1200	12000
2	20.00	0.0	30	600	12000
3	7.00	13.0	226	1600	11000
4	13.00	7.0	59	770	10000
5	16.00	4.0	45	720	12000

[4]

(b) ***V*** is the volume of **FA 1** used in cm^3 and ***t*** is the time taken in seconds. On your table above, compute the values of ***Vt*** and $\boldsymbol{V^2t}$ for each experiment, to 2 significant figures.

[1]

(c) The rate of the reaction in this investigation can be calculated using the following formula: **rate = 1 / reaction time**. Explain why this is so.

- **Rate of reaction is equal to the change in concentration of iodine with time. Since the same amount of thiosulfate is used in all experiments, the change in concentration of iodine is constant. So rate = 1 / reaction time.**

[1]

(d) Deduce the order of reaction with respect to iodide ions. Explain your answer by referring to your calculated values of ***Vt*** and $\boldsymbol{V^2t}$.

- **The reaction is second order with respect to iodide since V^2t is constant.**
- **V ∝ [FA 1]** since total volume is constant
  Rate = 1/*t*
  Since $\boldsymbol{V^2t}$ **= constant**
  1/t $\propto \boldsymbol{V^2}$
  Hence, **rate** $\propto$ **$[FA1]^2$**

[2]

(e) Another student investigated the effect of concentration of iron(III) ions on the rate of this reaction. The student carried out another experiment, **Experiment 6**, and the rate is compared to that of **Experiment 1**. Suggest the volumes the student could use for **Experiment 6**.

-

reagent	volume / cm^3
FA 1	**10**
FA 2	**20**
FA 3	**20**
FA 4	**10**
deionised water	**0**

[1]

[Total: 9]

2 In this experiment you will determine the formula of the ion, IO_x^-, To do this, you will first react IO_x^- ions with an excess of iodide ions, I^- to form iodine, I_2.

The equation for this reaction is:

$$IO_x^- + yI^- + zH^+ \rightarrow \frac{1+y}{2}I_2 + \frac{z}{2}H_2O$$

where x, y and z are all integers.

The amount of iodine produced will then be determined by titration with thiosulfate ions.

In addition to **FA 1**, **FA 3** and **FA 4** used in question **1**, you are also provided with the following.

FA 5 is a solution containing 0.00600 mol dm^{-3} IO_x^- ions.
FA 6 is 1.0 mol dm^{-3} sulfuric acid, H_2SO_4.

(a) Dilution of **FA 5**

1. Pipette 25.0 cm^3 of **FA 5** into the 250 cm^3 volumetric flask.
2. Make the solution up to the mark using deionised water.
3. Shake the flask thoroughly.
4. Label this diluted solution of IO_x^- as **FA 7**.

Titration

1. Pipette 25.0 cm^3 of **FA 7** into a conical flask.
2. Using the burette **labelled FA 1**, transfer 10.00 cm^3 of **FA 1** into the same conical flask.
3. Using a measuring cylinder, transfer 10 cm^3 of **FA 6** into the same conical flask.
4. Titrate the mixture in the conical flask against **FA 3** in the burette **labelled FA 3** until the solution turns yellow.
5. Add 10 drops of **FA 4** into the conical flask.
6. Continue the titration until the blue-black colour just disappears.
7. Carry out as many titrations as you deem necessary to obtain consistent results.
8. In the space provided, prepare a table to record all your burette readings and the volume of **FA 3** used in each titration.

Final burette reading / cm^3	**18.00**	**36.00**
Initial burette reading / cm^3	**0.00**	**18.00**
Volume of FA 3 added / cm^3	**18.00**	**18.00**

[5]

(b) (i) From your titration results, obtain a suitable volume of **FA 3** to be used in your calculations. Show clearly how you obtained this volume.

- **Volume of FA 3 used = (18.00 + 18.00) ÷ 2 = 18.00 cm^3**

[1]

(ii) Calculate the amount of iodine formed when 25.0 cm^3 of **FA 7** reacts with 10.00 cm^3 of **FA 1**. Show your working.

Amount of thiosulfate = 0.0050 × 0.0180 = 9.00 × 10^{-5} mol dm^{-3}
- **Amount of iodine formed = 9.00 × 10^{-5} ÷ 2 = 4.50 × 10^{-5} mol dm^{-3}**

[1]

(iii) Calculate the amount of IO_x^- in 25.0 cm^3 of **FA 7**. Show your working.

Concentration of IO_x^- in FA 7 = 0.00600 × 25 ÷ 250 = 0.000600 mol dm^{-3}
- **Amount of IO_x^- in 25.0 cm^3 of FA 7 = 0.000600 × 25 ÷ 1000 = 1.50 × 10^{-5} mol dm^{-3}**

[1]

(iv) Using your answer in **(b)(ii)** and **(b)(iii)**, determine the value of y. Show your working.

Amount of IO_x^- : Amount of I_2 = 1.50 x 10^{-5} : 4.50 x 10^{-5} = 1 : 3

- **1: (1+y)/2 = 1 : 3**
  y = 5

[1]

(v) Using your answer in **(b)(iv)**, determine the value of z. Hence, determine the value of x.

- **By balancing the charges on both sides of equation,**
  –1 –5 + z = 0
  z = 6
- **By balancing the number of O atom, x = 6/2 = 3.**

[1]

(c) (i) The maximum error in the volume dispensed by the pipette is ±0.06 cm^3.
Calculate the maximum percentage error in measuring the volume of **FA 5** used.

- **Percentage error = ± 0.06 / 25.0 x 100% = ± 0.24%**

[1]

(ii) A student suggested that a more accurate value of *x* can be determined if a 10.0 cm^3 pipette is used to measure the volume of **FA 6** rather than the measuring cylinder.

State whether you agree with this student. Explain your answer.

- **I do not agree with this student. FA 6 is used in excess, the exact volume of FA 6 will have no impact on the value of x.**

[1]
[Total: 12]

3 **FA 8** is a solid of Group 1 metal hydrogencarbonate, **L**HCO_3. When it is heated, carbon dioxide and stream are produced.

In this experiment you will determine the relative atomic mass of the metal **L** in **FA 8** using gravimetric analysis.

(a) Gravimetric Analysis

1. Weigh and record the mass of a dry boiling tube.
2. Transfer all the **FA 8** from the container into the boiling tube.
3. Reweigh and record the total mass of the boiling tube and **FA 8**.
4. Heat the boiling tube gently for approximately one minute and then strongly for another four minutes.
5. Leave the boiling tube to cool on a wire gauze for at least five minutes.
6. After cooling, reweigh the boiling tube and its contents.
7. Repeat the heating, cooling and weighing process until you are satisfied that the decomposition is complete. The residue is **FA 9**, keep the residue for use in **3(b)**.
8. Record your results in an appropriate form in the space below.

Results

Mass of empty boiling tube / g	**30.215**
Mass of boiling tube and FA 8 / g	**32.227**
Mass of FA 8 used / g	**2.012**
Mass of boiling tube and residue after first heating / g	**31.484**
Mass of boiling tube and residue after second heating / g	**31.484**
Mass of residue / g	**1.269**

[4]

(b) **(i)** Pour 1 cm depth of dilute hydrochloric acid into a test-tube.
Add a spatula measure of the residue, **FA 9** to the acid.

Record all your observations and identify any gas formed.

- **Effervescence of CO_2 gas which forms white precipitate in limewater.**

[1]

(ii) Use your observation in **(b)(i)** to identify the anion in **FA 9**. Assume that all the **L**HCO_3 has decomposed.

Anion in **FA 9** is • **CO_3^{2-}**

[1]

(iii) Hence, write a balanced equation for the thermal decomposition of **L**HCO_3. Include state symbols.

- **$2LHCO_3(s) \rightarrow L_2CO_3(s) + CO_2(g) + H_2O(g)$**

[1]

(iv) Calculate the amount of carbon dioxide given off in your experiment. Show your working.

- **Amount of CO_2 = $\frac{2.012-1.269}{44.0+18.0} = 0.0120$ mol**

[1]

(v) Hence, determine the relative atomic mass of metal **L**. Show your working.

Amount of $LHCO_3$ = 2 × 0.0120 = 0.0240 mol
Mr of $LHCO_3$ = $\frac{2.012}{0.0240} = 83.8$

- **Ar of L = 83.8 – (1.0 + 12.0 + 16.0 × 3) = 22.8** [1]

(c) (i) In another experiment, a student used a crucible with lid instead of a boiling tube for the heating and it was found that the results obtained were more accurate. Suggest why the crucible with lid can give a better result.

- **The residue may absorb water vapour from the surrounding during the cooling process, this lead to a higher than the expected mass reading.**

[1]

(ii) Another student conducted a different experiment to determine the A_r of **L** by measuring the volume of carbon dioxide formed in the following reaction.

$$\mathbf{L}HCO_3 + HCl \rightarrow \mathbf{L}Cl + CO_2 + H_2O$$

Suggest which method would give a more accurate determination of the A_r of **L**.

- **Gravimetric method is more accurate as the volume of gas collected will vary with temperature and pressure.**

OR

Gas collection is more accurate as the FA 8 may not be completely decomposed on heating.

[1]

[Total: 11]

4 Qualitative Analysis

(a) **FA 10** is a solid of a metal dioxide, **M**O_2.

Solution **S** is an acidic solution of sodium ethanedioate, $Na_2C_2O_4$.

You will perform tests to identify the element **M** in **FA 10**.

Perform the tests **(i)** and **(ii)** described in **Table 4.1** and record your observations in the table. The volume given below are approximate and should be estimated rather than measured.

Test and identify any gases evolved.

Table 4.1

	Tests	observations
(i)	Transfer all the solution **S** into a boiling tube and add one spatula of **FA 10** to the boiling tube. Warm the boiling tube cautiously. Leave the boiling tube to cool for about one minute and then filter the mixture into a test-tube.	• **Effervescence of CO_2 gas which gives white ppt with limewater.** • **Colourless filtrate obtained with black residue.**
(ii)	To a 1 cm depth of the filtrate from **(a)(i)** in a test-tube, add NaOH(aq). Leave to stand.	• **Off−white ppt. insoluble in excess.** • **Ppt. darkens on standing / turns brown / darker brown.**
(iii)	Aqueous hydrogen peroxide is added to an equal volume of H_2SO_4(aq) in a test-tube, followed by addition of one spatula of **FA 10.** The mixture is filtered into another test-tube. Leave the filtrate to stand.	Vigorous effervescence of O_2 which rekindles a glowing splint. A black/brown residue and a colourless filtrate obtained. The filtrate remains colourless.

[4]

(b) **(i)** Consider your observations in **(a)(ii),** give the name of the element **M** in **FA 10**. Explain your answer.

- **M is manganese**
- **An off−white precipitate, $Mn(OH)_2$ is formed with NaOH(aq) which is insoluble in excess and darkens/turned darker brown on standing.**

[2]

(ii) In **(a)(i)**, the reaction between **FA 10** and ethanedioate occurs under acidic conditions. Write a balanced equation for this reaction.

- **$MnO_2 + 4H^+ + C_2O_4^{2-} \rightarrow Mn^{2+} + 2H_2O + 2CO_2$**

[1]

(iii) The filtrate obtained in **(a)(i)** turned pale yellow on standing.

Compare the role of **FA 10** in **(a)(i)** and **(a)(iii)**. Explain your answer with reference to your observations in both tests.

- **In (a)(i), FA 10 is an <u>oxidising agent</u> because $C_2O_4^{2-}$ was oxidised to CO_2 that gives white precipitate in limewater while MnO_2 solid is reduced to colourless (or pale pink) Mn^{2+} ions.**

- **In (a)(iii), FA 10 is a <u>catalyst</u> as O_2 is formed since evolution of oxygen gas was vigorous or MnO_2 remained chemically unchanged as the filtrate remains colourless on standing (or the appearance of the residue is similar to original FA10).**

[2]

(c) **FA 11**, **FA 12** and **FA 13** are organic compounds with the molecular formulae C_7H_6O, C_3H_6O and C_2H_6O (not necessarily in any order).

Each compound has **only one** of the functional groups: alcohol, aldehyde and ketone.

(i) Perform the tests described in **Table 4.2** and record your observations in the table. If there is no observable change, write **no observable change**.

<u>Prepare of Tollens'reagent using the following procedure</u>.
Place a 2–3 cm depth of silver nitrate in a test-tube, add aqueous sodium hydroxide drop by drop until a small amount of brown precipitate is formed and then add aqueous ammonia drop by drop with shaking until the precipitate just dissolves. This is Tollens' reagent.

Table 4.2

test	Observations		
	FA 11	**FA 12**	**FA 13**
Add 1 cm depth of Tollens' reagent to test-tube containing 1 cm depth of each sample and place each test-tube in a hot water bath.	**No observable change**	**Silver mirror formed**	**No observable change**

[1]

(ii) Using only the bench reagents provided, suggest **one additional** chemical test that can help you identify the functional group present in each compound.
Describe the test in the space provided in **Table 4.3**.
Perform the test and record the observations in **Table 4.3**.

Table 4.3

test	observations		
	FA 11	**FA 12**	**FA 13**
To test-tube containing 1 cm depth of each sample, add 1 cm depth of dilute H_2SO_4 and then add about 10 drops of $KMnO_4$(aq). Place each test-tube in a hot water bath.	**Purple $KMnO_4$ decolourised**	**Purple $KMnO_4$ decolourised**	**No observable change**

[2]

(iii) Based on your observations in **(c)(i)** and **(c)(ii),** suggest the structures of the organic compounds present in **FA 11**, **FA 12** and **FA 13**.
FA 11 is **CH_3CH_2OH** **FA 12** is **C_6H_5CHO** **FA 13** is **CH_3COCH_3**

[3]
[Total: 15]

5 Planning

Self-heating food packaging is an active packaging with the ability to heat food contents without external heat sources or power. Packets typically use an exothermic chemical reaction. These packages are useful for military operations, during natural disasters or whenever conventional cooking is not available. These packages are often used to prepare main courses such as meat dishes, which are more palatable when hot.

The source of the heat is initiated by pressing on the heat pack. The heat pack is manufactured with the heating agent (anhydrous calcium chloride) separated from water by a thin breakable membrane. When pressure is applied on the packaging, a rod pierces the membrane, allowing the water and anhydrous calcium chloride to mix. The resulting reaction releases energy and thus warms the food surrounding it. The enthalpy change of solution for this dissolution process is approximately –83.0 kJ mol^{-1}.

$$CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2Cl^-(aq)$$

(a) Plan an investigation to determine the enthalpy change of solution when anhydrous calcium chloride is dissolved in deionised water using a non-graphical method.

You may assume that you are provided with:

- approximately 120 cm^3 of deionised water
- approximately 10 g of anhydrous calcium chloride
- a thermometer
- Styrofoam cup
- common apparatus in the laboratory

In your plan, you should include brief details of:

- calculation of a suitable mass of calcium hydroxide you would use for a temperature rise of about 12 °C to 14 °C;
- the apparatus you would use;
- the quantities of reagents you would use;
- the procedure you would follow and the measurements you would make (you may find it useful to label measurements in your plan as **M1**, **T1** etc);
- how you would ensure that a **reliable** value of the enthalpy change of solution is obtained

Assume that 4.18 J of heat energy raises the temperature of 1.0 cm^3 of the mixture by 1.0 °C.

Assume 50 cm^3 of water is used for each experiment and the temperature change is 13 °C.

Heat evolved = $mc\Delta T$ = 50 × 4.18 × 13 = 2717 J = 2.72 kJ

Amount of $CaCl_2$ dissolved = 2.72 ÷ 83 = 0.0328 mol

Mass of $CaCl_2$ = 0.0328 × (40.1 + 35.5 × 2) = 3.64 g

Procedure

1. **Add about 3.64 g of solid $CaCl_2$ into a weighing bottle.**
2. **Weigh and record the total mass of the $CaCl_2$ and the weighing bottle in g (M1).**
3. **Using a measuring cylinder, transfer 50 cm^3 of deionised water into a clean dry Styrofoam cup supported by a beaker.**
4. **Using a thermometer, measure and record the initial temperature of water (T1) in the Styrofoam cup in °C.**
5. **Add the $CaCl_2$ into the Styrofoam cup.**
6. **Stir the solution with the thermometer and record highest temperature reached (T2) in °C.**

7. Weigh and record the mass of the emptied weighing bottle in g (M2).
8. Repeat step 1 and 7 to get another set of results so as to obtain more reliable value for ΔH of solution.

[6]

(b) Describe how you would use the measurements in your plan in **(a)** to calculate a value for the enthalpy of solution of anhydrous calcium chloride.
[A_r: Ca = 40.1; C*l* = 35.5]

M_r of $CaCl_2$ = 40.1 + 35.5x 2 = 111.1
ΔT_{max} = (T2 – T1) °C
Mass of $CaCl_2$ used = (M1 – M2) g
Amount of $CaCl_2$ = $\frac{M1-M2}{111.1}$ mol

Heat evolved = mcΔT = 50 x 4.18 x (T2 – T1) = 209(T2 – T1) J

ΔH_{sol} = $-\frac{209(T2-T1)}{(M1-M2)/111.1}$ J mol^{-1}

[2]
[Total:8]

Qualitative Analysis Notes
[ppt. = precipitate]

(a) Reactions of aqueous 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)	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
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

(b) 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 pale cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq))
nitrate, NO_3^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil; NO liberated by dilute acids (colourless NO → (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)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in dilute strong acids)

(c) 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
sulfur dioxide, SO_2	turns aqueous acidified potassium manganate(VII) from purple to colourless

(d) Colour of halogens

halogen	***colour of element***	***colour in aqueous solution***	***colour in hexane***
chlorine, Cl_2	greenish yellow gas	pale yellow	pale yellow
bromine, Br_2	reddish brown gas/liquid	orange	orange–red
iodine, I_2	black solid / purple gas	brown	purple

Chemical List

Label	Per candidate	Identity
FA 1	220 cm^3	0.0500 $moldm^{-3}$ potassium iodide, KI
FA 2	75 cm^3	0.0350 $moldm^{-3}$ acidified iron(III) chloride, $FeCl_3$
FA 3	220 cm^3	0.00500 $moldm^{-3}$ sodium thiosulfate, $Na_2S_2O_3$
FA 4	100 cm^3	Starch indicator
FA 5	50 cm^3	0.0060 mol dm^{-3} potassium iodate(V), KIO_3
FA 6	75 cm^3	1.00 mol dm^{-3} sulfuric acid, H_2SO_4
FA 8	2.0 g	sodium hydrogencarbonate
FA 10	6 g	Manganese(IV) oxide, MnO_2
FA 11	10 cm^3	0.1 mol dm^{-3} ethanol, CH_3CH_2OH
FA 12	10 cm^3	0.1 mol dm^{-3} benzaldehyde
FA 13	10 cm^3	Diluted propanone, CH_3COCH_3
S	10 cm^3	Sodium ethanoedioate

Apparatus list

1	Two burettes – one labelled FA 1 and another labelled **FA 3**.
2	One 25.0 cm^3 pipette
3	One 10 cm^3 measuring cylinder
4	One 25 cm^3 measuring cylinder
5	One 50 cm^3 measuring cylinder
6	One 250 cm^3 volumetric flask
7	Three 250 cm^3 conical flasks
8	One 100 cm^3 beaker
9	One 200 cm^3 beaker
10	One pipette filler
11	One white tile
12	One stop watch
13	Two filter funnel
14	One Retort stand with burette clamp
15	One wash bottle with deionised water
16	One heatproof mat/wire gauze
17	One boiling tube
18	One test-tube rack
19	One test-tube holder
20	One Bunsen burner
21	One Delivery tube
22	One glass rod
23	One lighter
24	One small brush
25	One large brush
26	One Marker pen
27	One safety goggles
28	ACCESS to hot water
29	ACCESS to weighing balance
30	One spatula
31	Six teat/dropping pipette
32	Eight Test-tube
33	Two boiling tube
34	Three red litmus paper
35	Three blue litmus paper
36	Two paper towel
37	Two filter paper
38	Two wooden splinter