TEMASEK JUNIOR COLLEGE

2021 JC2 PRELIMINARY EXAMINATIONS

HIGHER 2

CANDIDATE NAME	
CIVICS GROUP	/
CENTRE NO. / INDEX NO.	/

CHEMISTRY **9729/04**

Paper 4 Practical **26 August 2021**

2 hours 30 minutes

Candidates answer on the Question Paper.

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

READ THESE INSTRUCTIONS FIRST

Write your Civics Group and name 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 an 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 19 and 20.
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	/ 12
2	/ 17
3	/ 14
4	/ 12
Total	/ 55

This document consists of 20 printed pages.

[Turn over

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

1 Determination of water of crystallisation in a hydrated iron(III) salt

A variety of hydrated iron(III) sulfates are known. Solutions of iron(III) sulfate are used in dyeing as a mordant, and as a coagulant for industrial wastes. **FA 1** is hydrated iron(III) sulfate with formula $Fe_2(SO_4)_3.nH_2O$. The addition of excess zinc to a solution of **FA 1** reduces the Fe^{3+} ions to Fe^{2+} ions.

The amount of Fe^{2+} ions can be determined quantitatively by titration against a standard solution of potassium manganate(VII), $KMnO_4$. The reaction is shown below.

$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

In this experiment, you are to prepare a standard solution using **FA 1** and perform titrations to determine the value of *n*, the water of crystallisation in **FA 1**.

You are provided with

FA 2, dilute sulfuric acid,
FA 3, 0.0200 mol dm^{-3} potassium manganate(VII), $KMnO_4$,
zinc powder.

(a) Preparation of standard solution of hydrated iron(III) salt

1. Weigh accurately about 6.5 g of the **FA 1** provided using the weighing bottle. Transfer all the solid into a 250 cm^3 beaker. Determine the mass of solid **FA 1** used and record all your weighings, to an appropriate level of precision, in the space below.

Mass of empty weighing bottle / g	**4.78**
Mass of weighing bottle and FA 1 / g	**11.28**
Mass of weighing bottle and residual FA 1 / g	**4.78**
Mass of FA 1 used / g	**6.50**

[1]

- **Tables have correct headers and units including correct subtraction**

2. Use a measuring cylinder to add about 100 cm^3 of **FA 2** to the beaker. Stir the mixture with a glass rod for 3 minutes. Ignore any cloudiness that remains.

3. Transfer the solution into a 250 cm^3 volumetric flask. Rinse the beaker with deionised water and pour the washings into the volumetric flask.

4. Make up to the 250 cm^3 mark with deionised water, stopper and mix thoroughly by inverting the flask a number of times.

5. Label this solution **FA 4**.

(b) Preparation of Fe^{2+} solution from FA 4

6. Use a measuring cylinder to transfer 100 cm^3 of **FA 4** into a 250 cm^3 beaker.

7. Add all the zinc powder into the beaker. Cover the beaker with a white tile.

8. Allow the reaction to take place for about 5 minutes, stirring the reaction mixture from time to time.

9. Filter the mixture into the **dry** conical flask provided using **dry** filter paper and filter funnel. Ignore any reaction that may still be taking place.

10. Label the filtrate as **FA 5**. Proceed to **1(c)** once you have collected sufficient filtrate.

(c) (i) Titration of FA 5 against FA 3

11. Fill a burette with **FA 3**.

12. Use a pipette to transfer 10.0 cm^3 of **FA 5** into a 250 cm^3 conical flask.

13. Use a measuring cylinder to add about 10 cm^3 of **FA 2** to this flask.

14. Titrate **FA 5** with **FA 3** from the burette until the appearance of the first permanent pale-pink colour.

15. Record your titration results, to an appropriate level of precision, in the space below.

16. Repeat steps 12 to 15 until consistent results are obtained.

Titration Results

Final burette reading / cm^3	**9.20**	**9.20**
Initial burette reading / cm^3	**0.00**	**0.00**
Volume of FA 3 used / cm^3	**9.20**	**9.20**
	√	√

- **Tables have correct headers and units**
  Note: Mark is lost if any final and initial burette readings are inverted or 50 is used as the initial burette reading.
- **All mass reading in (a) are recorded to 2 or 3 dp and burette readings & volume used for all accurate titres in the titration table are recorded to 2dp.**
- **At least two uncorrected titres for end-point within ±0.10 cm^3.**

[3]

(ii) From your titrations, obtain a suitable volume of **FA 3**, $V_{FA\,3}$, to be used in your calculations. Show clearly how you obtained this volume.

Average titre = $\frac{9.20 + 9.20}{2}$
= ● 9.20 cm^3

Answer should be recorded to 2.d.p
Mark is lost if there are arithmetic errors in the table.
Mark is lost if the titres used are not identified either in the table (by, for example, a tick) or in a calculation.

Accuracy
Supervisor's $V_{FA\,4}$ / $m_{FA\,3}$ = 1.42
Difference between student's and supervisor's $V_{FA\,4}$ / $m_{FA\,3}$

2 marks: If difference is ≤ 0.045 cm^3 g^{-1}
1 mark: If difference is > 0.045 but ≤ 0.075 cm^3 g^{-1}
0 mark: For a difference > 0.075

$V_{FA\,3}$ = ……[3]

(d) **(i)** Calculate the amount of Fe^{2+} in 10.0 cm^3 of **FA 5**.

$5Fe^{2+} \equiv MnO_4^-$
No. of moles of Fe^{2+} = 9.20/1000 × 0.020 × 5
= 9.20 x 10^{-4} mol

amount of Fe^{2+} in 10.0 cm^3 of **FA 5** = …… [1]

(ii) In step 7, an excess of zinc was added to convert the Fe^{3+} to Fe^{2+}.

Calculate the amount of Fe^{3+} in 250 cm^3 of **FA 4**.

No. of moles of Fe^{3+} = 9.20 x 10^{-4} x $\frac{250}{10}$
= 0.0230 mol

amount of Fe^{3+} in 250 cm^3 of **FA 4** = …… [1]

(iii) Use your answer from **1(d)(ii)** to calculate the M_r of the hydrated iron(III) sulfate, $Fe_2(SO_4)_3.nH_2O$, in **FA 1**.

$Fe_2(SO_4)_3.nH_2O \equiv 2Fe^{3+}$

No. of moles of $Fe_2(SO_4)_3.nH_2O$ = 0.0230 / 2 mol
= 0.0115 mol

M_r of $Fe_2(SO_4)_3.nH_2O$ = 6.50 / 0.0115
= 565.2

M_r of the hydrated iron(III) sulfate = ...

Hence, deduce the value of n, the water of crystallisation in the hydrated iron(III) sulfate.

[A_r: Fe, 55.8; S, 32.1; O, 16.0; H, 1.0]

n = {565.2 – [2(55.8) + 3(32.1) + 12(16.0)]} ÷ 18.0
= 9 (nearest whole number)

n = ...
[2]

(e) In step 9, excess zinc was filtered off before titration of **FA 5** against **FA 3** to avoid any possible reaction between zinc and **FA 3**.

Suggest another reason why it was necessary to filter off the excess zinc metal, and what effect failing to do it would have on the titre values.

[1]

- **Zinc metal that is not removed will continue to reduce Fe^{3+} formed during the titration to Fe^{2+}, resulting in a higher than expected titre.**

[Total: 12]

2 Determination of the enthalpy change of neutralisation by graphical analysis

The neutralisation reaction between sulfuric acid and sodium hydroxide is exothermic.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

FA 2 is sulfuric acid, H_2SO_4.
FA 6 is 1.50 mol dm^{-3} sodium hydroxide, NaOH.

In this question, you will add different volumes of **FA 6** to a fixed volume of **FA 2**. By measuring the temperature changes that occur, it is possible to determine the neutralisation point. This is the point at which just enough alkali has been added to react with all the acid present.

The aim of the investigation is to determine the enthalpy change of neutralisation for the reaction between sulfuric acid and sodium hydroxide.

Take care as aqueous solutions of sodium hydroxide are corrosive.
Read through the following instructions carefully before starting any practical work.

(a) 1. Fill the burette with **FA 6**.

2. Place a polystyrene cup inside a 250 cm^3 beaker to provide support for the cup.

3. Use a measuring cylinder to transfer 30.0 cm^3 of **FA 2** into the cup and record the steady temperature of **FA 2**, T_1, in the space below.

T_1 = ……**29.0**……°C

4. Add 5.00 cm^3 of **FA 6** from the burette to the cup, stir the mixture thoroughly with the thermometer and record the temperature of the solution.

5. Add a further 5.00 cm^3 of **FA 6** to the cup and again record the temperature.

6. Continue the addition of **FA 6**, in 5.00 cm^3 portions, until a total of 35.00 cm^3 of **FA 6** have been added from the burette. Measure the temperature after each addition.

7. Record the total volume of **FA 6** added, total volume of solution, V_T, and all temperatures, T_x, in Table 2.1 on page 8.

   Record V_T to 1 decimal place and the total volume of FA 6 and T_x to an appropriate level of precision.

Note: If you overshoot on an addition, record the <u>actual</u> volume of FA 6 added up to that point.

Table 2.1

Total volume of **FA 6** added / cm^3	Total volume of solution in cup, V_T / cm^3	Temperature, T_x / °C	ΔT / °C	V_T x ΔT / cm^3 °C
5.00	**35.0**	**32.0**	**3.0**	**105**
10.00	**40.0**	**34.2**	**5.2**	**208**
15.00	**45.0**	**36.2**	**7.2**	**324**
20.00	**50.0**	**37.8**	**8.8**	**440**
25.00	**55.0**	**37.0**	**8.0**	**440**
30.00	**60.0**	**36.2**	**7.2**	**432**
35.00	**65.0**	**35.6**	**6.6**	**429**

After each addition of **FA 6**, the temperature rise, ΔT, is given by,

$\Delta T = T_x - T_1$.

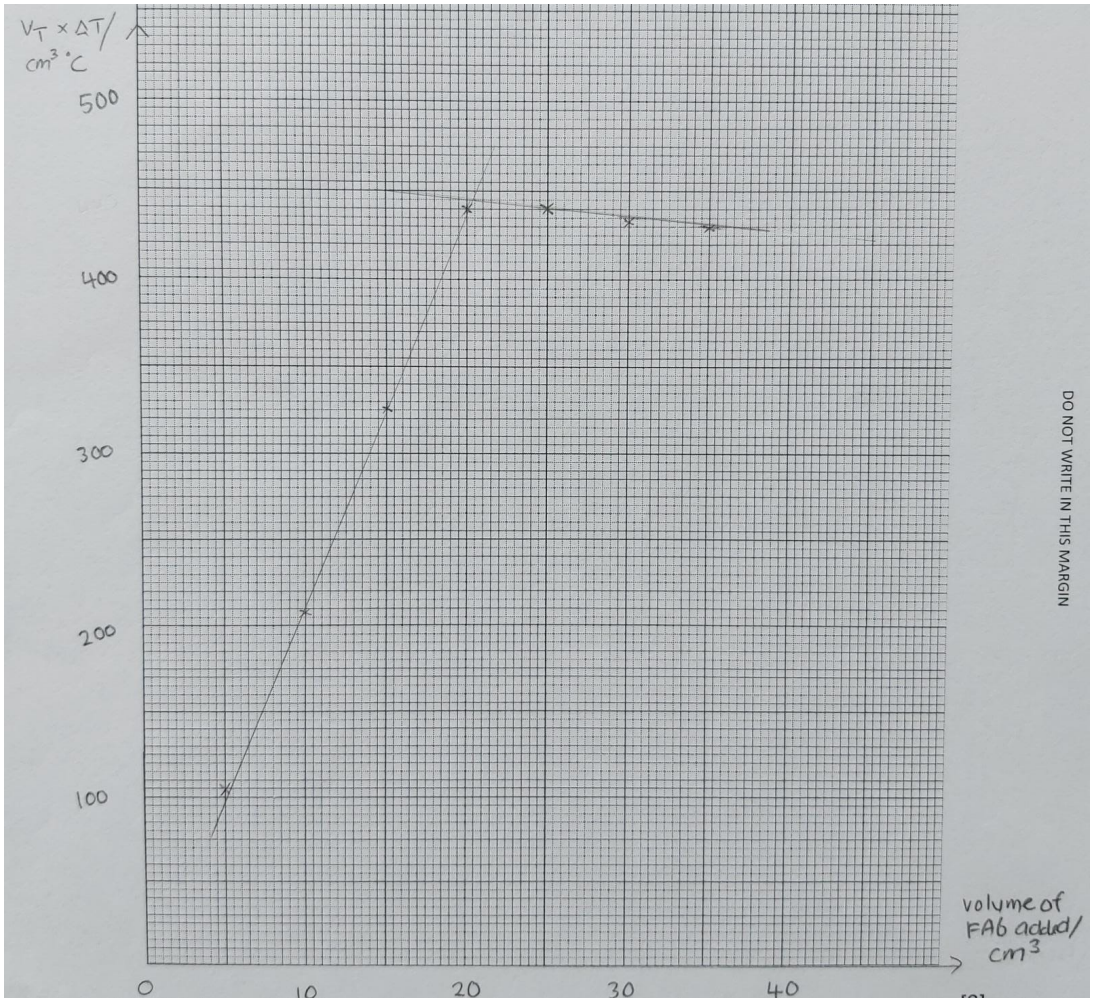
Complete Table 2.1 by calculating ΔT to 1 decimal place and (V_T x ΔT) for each measurement.

[4]

- **Correct recorded total volume of FA 6 and to the nearest 0.05 cm^3, Total volume of solution, T_x and ΔT to the nearest 0.1 °C, (V_T x ΔT) to 3 sf.**
- **Correctly calculates V_T, ΔT and (V_T x ΔT).**
- **•• Compare temperature rise for addition of 25 cm^3 of FA 6 with the Supervisor value. Award 2 marks for ΔT within ±1 °C. Award 1 mark for ΔT within ±2 °C.**

(b) Plot a graph of (V_T x ΔT) on the y-axis against the volume of **FA 6** added on the x-axis.

Draw two straight lines of best-fit through the plotted points to find the neutralisation point for the reaction.



[3]

- **Axes correct way round + correct labels + units.**
  Appropriate scale. Linear scales chosen so that graph occupies more than half the available length for both axes.
- **All points plotted correctly. Points must be within half a small square of the correct position.**
- **Draw both straight lines of best fit showing correct trend before and after equivalence point.**

(c) From your graph, determine the volume of **FA 6** and (V_T x ΔT) at the neutralisation point.

volume of **FA 6** = ….**20.5**…… cm^3

V_T x ΔT = ……**445**……cm^3 °C

[1]

- **Reads correctly the value of FA 6 and (V_T x ΔT) from the intercept of the two lines, to ½ the smallest square.**

(d) Calculate the enthalpy change of neutralisation for the reaction between sulfuric acid and sodium hydroxide.

You should assume that the:
- specific heat capacity of the mixture is 4.18 J g^{-1} K^{-1};
- density of the mixture is 1.00 g cm^{-3}.

amt of NaOH neutralised = 20.5/1000 x 1.50 = 0.03075 mol = amt of H_2O formed

V_T x ΔT = 445
(30.0 + 20.5) x ΔT = 445
ΔT = 8.81 °C

- **heat released by neutralisation = m c ΔT**
  = (30.0 + 20.5) (4.18) (8.81)
  = 1860 J

- **enthalpy change of neutralisation = – 1860 / 0.03075**
  = – 60500 J mol^{-1}
  = – 60.5 kJ mol^{-1}

enthalpy change of neutralisation = ……**– 60.5 kJ mol^{-1}**…… [2]

(e) Fig. 2.1 was obtained when ΔT was plotted against the volume of **FA 6** added.

Explain the shape of the graph in Fig. 2.1 before the equivalence point and after the equivalence point.

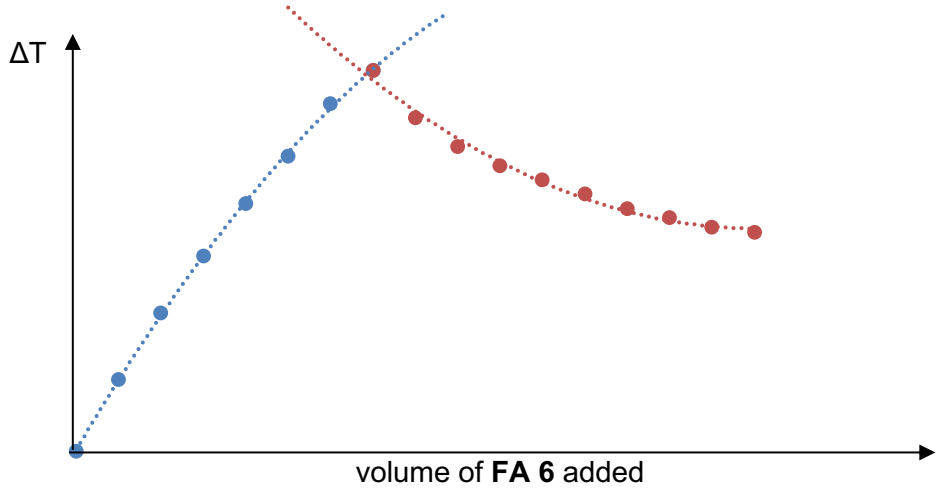


Fig. 2.1

Before the equivalence point:
Each addition of FA 6 causes the √ temperature of the mixture to rise as the reaction between FA 6 (NaOH) and FA 2 (H_2SO_4) is √ exothermic.

Each rise in temperature is smaller than before because the same amount of heat is produced but spread over an increasing volume as the √ total volume of mixture is larger. Hence, curved lines are obtained.

After equivalence point, √ FA 2 has reacted completely. Hence, no more heat is produced and the √ temperature of the mixture falls (to a lower temperature/room temperature).

Each temperature fall is smaller than before as there is a √ smaller extent of cooling since the temperature of the mixture is now closer to temperature of the NaOH solution (Or smaller extent of cooling due to increasing total volume).

[3]

2 √: 1m

(f) In the experiment you have performed, determine whether using a measuring cylinder or a burette to measure each 5.00 cm^3 portion will be more accurate.

The errors (uncertainties) associated with each reading using a measuring cylinder and burette are ±0.5 cm^3 and ±0.05 cm^3 respectively.

Show calculations to justify your answer.

- **% error of measuring cylinder = $\frac{0.5}{5.00}$ x 100 = ± 10.0%**
  % error of burette = $\frac{2 \times 0.05}{5.00}$ x 100 = ± 2.00%

- **The <u>burette</u> would be a <u>more accurate</u> apparatus as it has a <u>smaller percentage error</u>.**

[4]

- Shows working in all calculations in **1(d)** and **2(d)**.
  Any calculations must be relevant although they may not be complete or correct.
  Any calculation not attempted loses this mark.
- Shows appropriate significant figures (3 or 4 sf) in all final answers in **1(d)(i), 1(d)(ii)** and **2(d)**. For **1(d)(iii)**, M_r given to 1dp and n to nearest whole number.
  Shows appropriate units for all answers in **1(d)** and **2(d)**.
  Any calculation not attempted loses this mark.

[Total: 17]

3 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 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.

FA 7 is an aqueous solution that contains a mixture of salts with two cations and two anions listed in the Qualitative Analysis Notes.

Test	Procedure	Observation
(a)	Test the **FA 7** solution using Universal Indicator paper.	√ **pH 2-4** √ **Yellow universal indicator paper changes to orange**
(b)	To 2 cm depth of **FA 7**, add aqueous sodium hydroxide dropwise with shaking till 4 cm depth is added. Swirl and filter the mixture, collecting the filtrate in a test-tube. The filtrate is **FA 8** which should be put to one side for use in **(c)**. Wash the residue thoroughly with deionised water. Discard the washings. The residue is **FA 9**. Retain the residue for use in **(d)(i)**.	√ **Red-brown ppt formed, insoluble in excess NaOH.** √ **red-brown residue** √ **colourless filtrate**
(c)(i)	To 1 cm depth of **FA 8**, carefully add nitric acid dropwise until no further change is seen.	√ **white ppt forms** √ **that dissolves in excess HNO_3** √ **no gas evolved**
(c)(ii)	To 1 cm depth of **FA 8**, heat gently. Add aluminium foil and heat gently.	√ **no gas evolved** √ **effervescence observed.** √ **Pungent, colourless, alkaline gas evolved that turned moist red litmus paper blue evolved.**

(c)(iii)	To 1 cm depth of **FA 8**, add 1 cm depth of nitric acid, followed by silver nitrate.	**no gas/effervescence evolved** **√ white ppt observed**
(d)(i)	Transfer the residue, **FA 9**, into a clean test-tube. Carefully add **FA 2**, a few drops at a time with shaking, until all of the residue dissolved. This solution is **FA 10.** Use **FA 10** for **(d)(ii)**.	**√ yellow/orange solution obtained or orange solution turns colourless on standing.**
(d)(ii)	To 1 cm depth of **FA 10**, add a few drops of KI. Leave to stand.	**No ppt** **√ Solution turns darker yellow/orange.**

2 √ : 1m

[7]

(e) From your observations in **(c)(i)**, suggest the possible identity of the cations present in **FA 8**. [1]

Cations : **Al^{3+} or Zn^{2+}**

(f) Explain the observations when nitric acid was added to **FA 8** in **(c)(i).** [1]

Addition of HNO_3(aq), neutralizes the base present in FA 8 causing the soluble complex $[Al(OH)_4]^-$ to form back the white ppt of $Al(OH)_3$. In excess acid, the white ppt dissolves to form Al^{3+}(aq).

(g) Suggest the identity of the two anions present in **FA 7**, explain your reasoning. [3]

√ NO_3^- (accept NO_2^- & NO_3^-) is present as √ ammonia gas is evolved when it is heated with aqueous NaOH and aluminium. It √ cannot be NO_2^- as there is √ no brown gas evolved when HNO_3 was added.
√ Cl^- is present as a √ white precipitate is formed with FA 8 when silver nitrate was added in the presence of acid.

Every 2 √: 1 mark

(h) Identify the cation present in **FA 9**. [1]

- **Fe^{3+}**

(i) Using your observation in **(d)(ii)**, suggest whether iodine is a stronger oxidising agent than the cation in **FA 9**. [1]

- **Since iodide was oxidised to iodine and the cation in FA 9 was reduced, iodine is a weaker oxidising agent than the cation (Fe^{3+}) in FA 9.**

[Total: 14]

[Turn over

4 Planning

(a) Calcium hydroxide, $Ca(OH)_2$, is a sparingly soluble salt.

A 25.0 cm^3 saturated solution containing $Ca(OH)_2$ dissolved in 0.020 mol dm^{-3} NaOH at 25 ºC was titrated with HC*l*.

Determine a suitable concentration of hydrochloric acid needed for the titration. You are to assume that the solubility of $Ca(OH)_2$ in 0.020 mol dm^{-3} aqueous sodium hydroxide at 25 ºC is approximately 5.00 x 10^{-3} mol dm^{-3}. [3]

$Ca(OH)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq)$

$NaOH \rightarrow Na^+ + OH^-$

• Total $[OH^-] = 0.020 + 2(0.005) = 0.0300$ mol dm^{-3}

Amount of OH^- in 25.0 cm^3 = 0.03 x 25.0/1000 = 7.50 x 10^{-4} mol

• Amount of HC*l* required = 7.50 x 10^{-4} mol

• Assume average titre = 25.00 cm^3

[HC*l*] required = 7.50 x 10^{-4} / 0.025 = <u>0.0300 mol dm^{-3}</u>

(b) Using the concentration of dilute hydrochloric acid, HC*l*, that you have determined in **(a)**, you are to plan an experiment to determine

- the solubility of $Ca(OH)_2$ in 0.020 mol dm^{-3} aqueous sodium hydroxide and
- the solubility product of $Ca(OH)_2$ at 25 °C.

Your plan should include **(1)** the procedure you would follow with the appropriate choice of apparatus and the **(2)** measurements to be made.

You may assume that you are provided with:

- solid calcium hydroxide, $Ca(OH)_2$,
- 0.020 mol dm^{-3} aqueous sodium hydroxide, NaOH,
- dilute hydrochloric acid, HC*l*, of concentration you determined in **(a)**
- methyl orange,
- the apparatus and equipment normally found in a school or college laboratory. [6]

M1: choice of apparatus	Prep of saturated solution: measuring cylinder / burette, conical flask / beaker Titration: pipette, burette

M2: prepare saturated solution	**1.** Using a measuring cylinder / burette, transfer 150 cm^3 of 0.020 mol dm^{-3} aqueous sodium hydroxide into a dry 250 cm^3 beaker / conical flask. **2.** Using a spatula, add solid $Ca(OH)_2$ into the beaker. Stir the contents in the beaker using a glass rod until no more solid can dissolve. **3.** Allow the solution to stand for a few minutes with occasional stirring or swirling.
M3: maintain constant temp	**4.** Immerse the beaker in a thermostatically controlled water bath maintained at 25 °C.
M4: filtration using dry apparatus	**5.** Filter the solution through a dry filter paper into a dry conical flask / dry beaker.
M5: titration with end point colour change	**6.** Pipette 25.0 cm^3 of the filtrate into a conical flask. Add 2-3 drops of methyl orange indicator into the conical flask. **7.** Titrate with 0.0300 mol dm^{-3} hydrochloric acid from the burette. **8.** The end-point is reached when the solution in the conical flask changes from yellow to orange colour.
M6: consistent results	**9.** Repeat the titration to get at least two consistent results.

(c) **(i)** Given that you obtain a titre value of 24.00 cm^3 HC*l* from your experiment in **(b)**, calculate the solubility of $Ca(OH)_2$ in 0.020 mol dm^{-3} sodium hydroxide solution. [2]

Amt of H^+ used = total amt of $OH^-(aq)$ in 25.0 cm^3 saturated soln

= 24/1000 x 0.030 = 7.20 x 10^{-4} mol

$Ca(OH)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq)$

$NaOH \rightarrow Na^+ + OH^-$

- **Total $[OH^-]_{sat}$ = 7.20 x 10^{-4} / 0.025 = 0.0288 mol dm^{-3}**
- **$[Ca^{2+}]$ = ½ (0.0288 – 0.020) = 4.40 x 10^{-3} mol dm^{-3}**

Solubility of $Ca(OH)_2$ in 0.020 mol dm^{-3} NaOH = 4.40 x 10^{-3} mol dm^{-3}

(ii) Hence, calculate the solubility product of $Ca(OH)_2$. [1]

$K_{sp} = [Ca^{2+}][OH^-]^2 = 4.40 \times 10^{-3} \times (0.0288)^2$ mol^3 dm^{-9}

= • <u>3.65×10^{-6}</u> mol^3 dm^{-9}

[Total: 12]

Chemicals List

List of chemicals	Quantity of chemicals (for each student)
FA 1: hydrated iron (III) sulfate	Balance area
FA 2: 0.60 mol dm^{-3} sulfuric acid, H_2SO_4	180 cm^3
FA 3: 0.0200 mol dm^{-3} potassium manganate (VII), $KMnO_4$	70 to 80 cm^3
Zinc powder	5.00 g (estimated) (pre-weighed in a weighing bottle)
FA 6 : 1.5 mol dm^{-3} NaOH	70 cm^3
FA 7: Mixture of 0.05 mol dm^{-3} iron(III) chloride, 0.1 mol dm^{-3} aluminium chloride, 0.1 mol dm^{-3} sodium nitrate.	6 cm^3
Universal indicator paper with colour chart	1 strip
Aluminium foil	2 to 3
QA Reagent: NaOH, Ammonia, 0.10 mol dm^{-3} KI silver nitrate, nitric acid, limewater (use old stock)	1 set
Red litmus paper and blue litmus paper, wooden splint	

Chemicals

FA 1 (near mass balance)

FA 2

FA 3

FA 6

FA 7

Zinc powder

QA Reagents: Sodium hydroxide, Ammonia, Potassium iodide, silver nitrate, nitric acid, limewater, Aluminium foil

Apparatus

- 1 x Dry empty weighing bottle labelled as FA 1
- 6 x Test-tubes
- 2 x Droppers
- 1 x Spatula
- 3 x Filter paper
- 4 x Paper Towel
- 2 x Red litmus paper
- 2 x blue litmus paper
- 2 x Universal Indicator paper
- 1 x Styrofoam Cup
- 1 x Dry 250 cm^3 conical flask
- 1 x Dry filter funnel
- 1 x Gloves
- 1 x Styrofoam Cup
- 1 x Dry 250 cm^3 conical flask
- 1 x Dry filter funnel
- 1 x Gloves
- 2 x Burette
- 1 x Burette Clamp and stand
- 2 x White tile
- 1 x 10 cm^3 pipette
- 1 x pipette filler
- 1 x Filter funnel
- 1 x 250 cm^3 volumetric flask
- 2 x 250 cm^3 conical flasks
- 2 x 250 cm^3 beaker
- 1x wooden splint
- 1 x 100 cm^3 measuring cylinder
- 1 x 50 cm^3 measuring cylinder
- 1 x Thermometer (with divisions of 0.2 ^oC)
- 1 x Glass Rod
- 1 x Deionised water
- 1 x Test-tube rack
- 1 x Test-tube holder
- 1 x Bunsen Burner
- 1 x Lighter
- 1 x Delivery Tube
- 1 x Marker
- 1 x Safety Goggles
- 1 x Universal Indicator colour chart