OCR
Oxford Cambridge and RSA

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Practice paper – Set 2

Time allowed: 1 hour 30 minutes

You must have:
- the Insert (inserted)
- the Data Sheet for Chemistry B (Salters)

You may use:
- a scientific or graphical calculator

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- The practical insert is needed with this paper.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **16** pages.

Answer **all** the questions

1 Two students aim to prepare a sample of phenyl benzoate using the reaction below.

$$\underset{\textbf{benzoyl chloride}}{C_6H_5COCl} + \underset{\textbf{phenol}}{C_6H_5OH} \rightarrow \underset{\textbf{phenyl benzoate}}{C_6H_5CO_2C_6H_5} + HCl$$

(a) Draw structural formulae for the organic compounds in the boxes below. **[1]**

C_6H_5COCl	C_6H_5OH	$C_6H_5CO_2C_6H_5$

(b) The students weigh out the phenol in a weighing bottle and shake it with excess alkaline benzoyl chloride.
They collect and purify their product and weigh it in a sample bottle.
The students' results are given below.

Mass of weighing bottle + phenol / g	27.70
Mass of weighing bottle after emptying / g	22.68
Mass of sample bottle / g	6.16
Mass of sample bottle + purified phenyl benzoate / g	11.50
Melting point of phenyl benzoate / °C	67–69

(i) Calculate the percentage yield of the phenyl benzoate.

percentage yield = ... % **[3]**

(ii) Suggest why the percentage yield is relatively low.

....

.... **[1]**

(iii) A textbook value for the melting point of phenyl benzoate is 69 °C.

Comment on the purity of the sample produced by the students.

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.... **[1]**

(c)* The students purified the phenyl benzoate by recrystallisation from a suitable solvent.

Describe and explain the steps in the purification of an organic solid by recrystallisation, including the properties needed of a suitable solvent.

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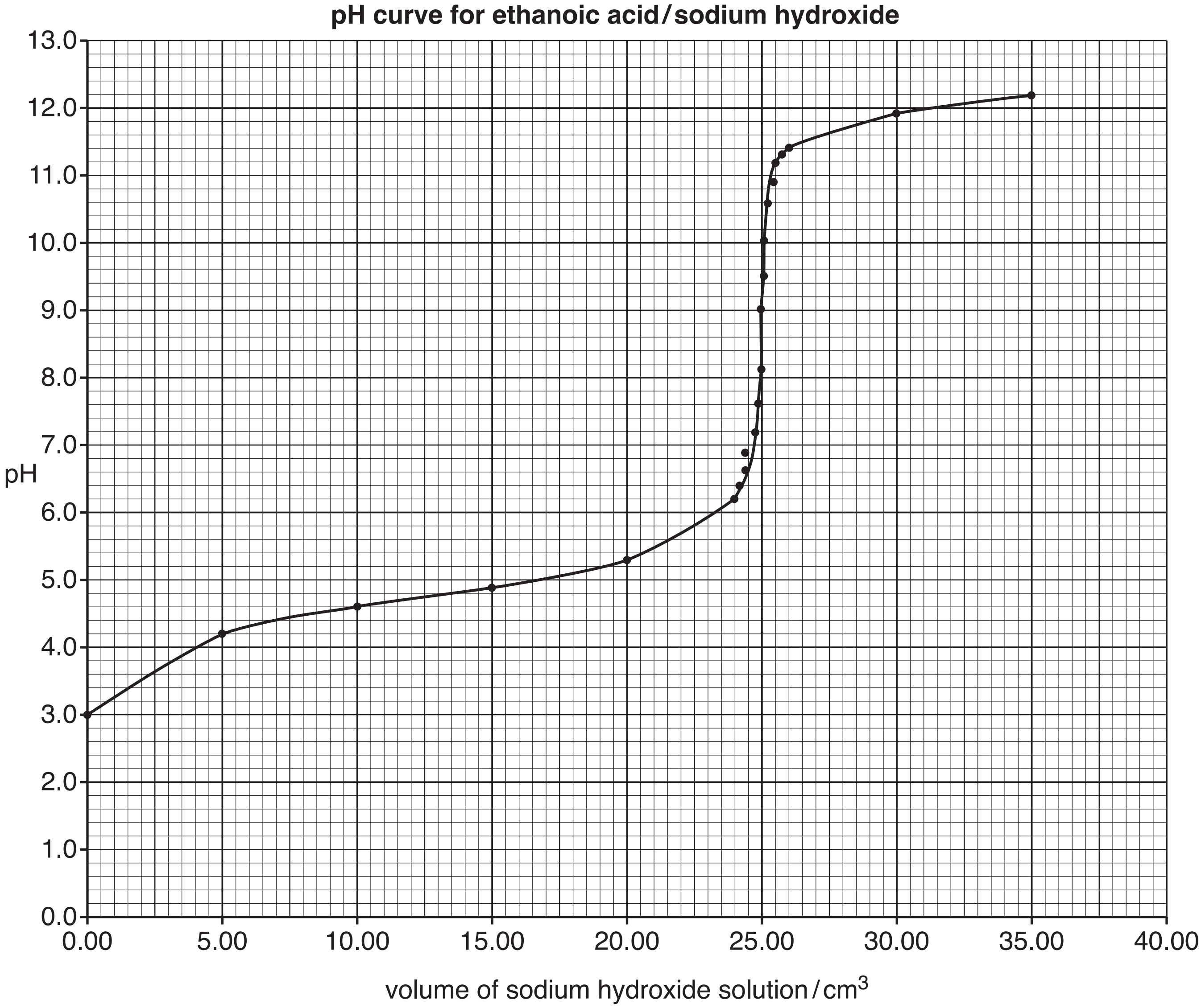
.... **[6]**

2 A student uses a pH meter to measure the pH of the solution when 0.10 mol dm^{-3} sodium hydroxide is added to a solution of ethanoic acid. The student's results are shown in the graph below.



(a) **(i)** Explain why the student decided to use a pH meter rather than universal indicator to determine the pH of the solution as the titration progressed.

....

.... **[1]**

(ii) The pH meter should have been calibrated by the student before use.

Explain how a pH meter is calibrated.

....

.... **[1]**

(b) **(i)** Ethanoic acid is a weak acid.

Give an equation for its ionisation in water.

[1]

(ii) Use the graph to find the pH when $[CH_3COOH] = [CH_3COO^-]$ and from that the value of K_a for ethanoic acid.

K_a = ... $mol\,dm^{-3}$ **[4]**

(c) A solution of sodium ethanoate and ethanoic acid forms a buffer solution.

(i) What is a buffer solution?
Explain how a sodium ethanoate/ethanoic acid solution acts as a buffer solution.

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.... **[4]**

(ii) A student measures the pH of a sodium ethanoate/ethanoic acid buffer solution before and after adding a small amount of distilled water to the buffer.

Describe and explain any change in the pH after the addition of the water.

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.... **[2]**

(d) The student decides to repeat the experiment using two different indicators to see whether the colour change matches the equivalence point shown by pH titration.

The indicators are weak acids and can be represented by the formula HIn.
Indicators partially ionise in solution where the HIn molecule has a different colour to the In^- anion.

$$HIn(aq) \rightleftharpoons H^+(aq) + In^- (aq)$$

The table below gives some information on two possible indictors that could be used in the experiment.

Indicator	Colour of HIn	Colour of In^-	pH range over which indicator changes colour
phenolphthalein	colourless	pink	8.2–10
methyl orange	red	yellow	3.2–4.4

(i) Suggest, with reference to the pH curve on page 4, and the information in the table above, which indicator would be suitable for this titration.

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.... **[2]**

(ii) Use the information in the table above to predict which indicator ionises more when dissolved in distilled water.
Explain your prediction.

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.... **[2]**

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3 A group of students set out to investigate the cooling effect caused by liquids evaporating.
The faster a liquid evaporates the greater the cooling effect.
They want to see if this is linked to the strength of the intermolecular bonding in the liquids.

(a)* The students placed a drop of each liquid on a thermometer strip which changes colour according to the temperature. The liquids used and their results are summarised below.

Water	**Ethanol**	**Propanone**	**Pentane**	**2-Methylbutane**
H_2O	C_2H_5OH	$(CH_3)_2CO$	C_5H_{12}	$CH_3CH(CH_3)CH_2CH_3$
Drop in temperature after two minutes				
least ——————————————→ greatest				

Table 3.1

Interpret the students' results in terms of intermolecular bonding and enthalpy changes.

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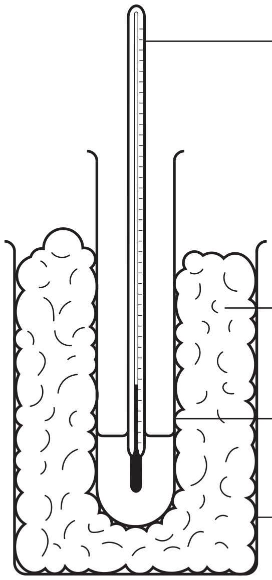
.... **[6]**

(b) The students go on to investigate whether mixing pairs of the liquids results in a temperature change.
They used the following apparatus and the results for two pairs of the liquids are shown in **Table 3.2**.



Liquid A	**Liquid B**	**Starting temperature, Liquid A / °C**	**Starting temperature, Liquid B / °C**	**Finishing temperature on mixing / °C**	**Temperature change, ΔT / °C**
Ethanol	cyclohexane	23.0	23.0	19.5	3.5
pentane	2-methylbutane	23.0	23.0	23.0	0.0

Table 3.2

(i) Explain the purpose of the cotton wool.

....

.... **[1]**

(ii) When the pairs of liquid A and liquid B are mixed, there are three possible intermolecular bonds between the molecules in the mixture.
These are A-A, B-B and A-B intermolecular bonds.

Explain the temperature change in the ethanol/cyclohexane mixture shown in **Table 3.2**, in terms of the intermolecular bonds A-A, B-B, and A-B.

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.... **[2]**

(iii) Using ideas of bond breaking and making, suggest why there is no temperature change in the pentane/2-methylbutane mixture.

....

.... **[1]**

(c) A student reads that molecules of trichloromethane, $CHCl_3$, and methyl ethanoate, CH_3COOCH_3, do not form hydrogen bonds with themselves, but when mixed, do so with each other. See **Fig 3.1** below.

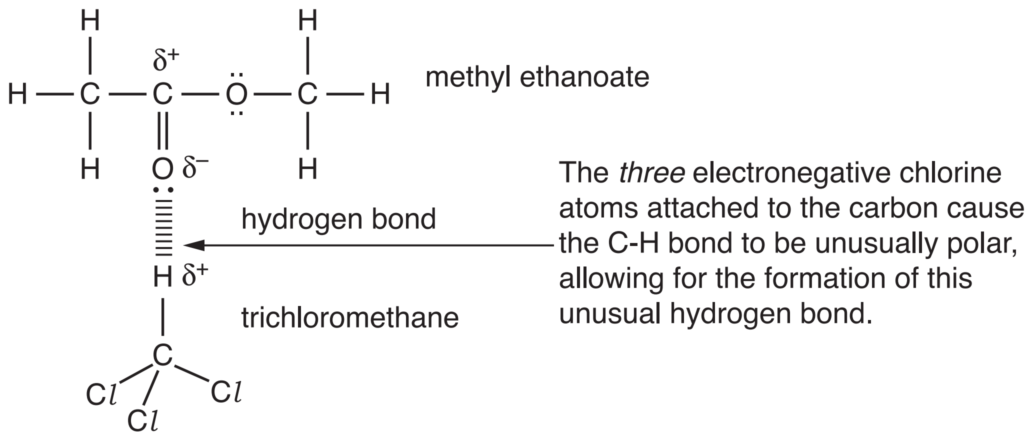

Fig. 3.1

The student tries to measure the strength of the hydrogen bond between molecules of the liquids. They are given the following data.

Liquid	**Density / $g\,cm^{-3}$**	**Specific heat capacity / $J g^{-1} K^{-1}$**
Trichloromethane	1.48	0.96
methyl ethanoate	0.93	2.10

Table 3.3

(i) Using the same apparatus as in part **(b)** the student mixes equimolar quantities of the two liquids and measures the temperature change.

Calculate the volumes of the two liquids you need to mix in order to give a solution that contains 0.15 moles of each liquid.
Give your answer to an **appropriate** number of significant figures.

volume of trichloromethane = ... cm^3

volume of methyl ethanoate = ... cm^3
[3]

(ii) Suggest a piece of apparatus that would be most suitable for measuring out your calculated volumes.

.... **[1]**

(iii) The student measures a temperature rise of 11.0 °C when the calculated volumes are mixed.

Calculate the heat energy transferred to each liquid and hence the strength, in $kJ\,mol^{-1}$, of the hydrogen bond between molecules of the liquids.

Liquid	**Density / $g\,cm^{-3}$**	**Specific heat capacity / $J\,g^{-1}\,K^{-1}$**
trichloromethane	1.48	0.96
methyl ethanoate	0.93	2.10

strength of hydrogen bond = ... $kJ\,mol^{-1}$ **[3]**

4 This question refers to the *Practical Insert* that is provided as an insert to this paper.

(a) **(i)** Suggest and explain a mistake in the student's procedure which may have led to the titre values in the first set of results showing an increase.

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.... **[2]**

(ii) Choose suitable values from the student's second set of titration results to calculate the concentration of the original sulfamic acid solution.
Give your answer to **two** significant figures.

concentration = ... $mol\,dm^{-3}$ **[4]**

(iii) The concentration of sulfamic acid solution given on the bottle of limescale remover is slightly lower than the student's value.

Suggest how the sodium hydroxide solution may have caused this difference.

....

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.... **[2]**

(b) In **Part B** of the experiment, sulfamic acid reacts with excess carbonate as in the equation below.

$$2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$$

(i) Use the data from the results section in **Part B** of the insert to calculate the M_r of the sulfamic acid.

You may assume that all the acid reacts and that the reaction takes place at room temperature and pressure.

M_r = ... **[4]**

(ii) The measuring cylinder used to collect the carbon dioxide has an uncertainty of ± 1 cm^3. Calculate the percentage uncertainty in the volume of CO_2 measured.

percentage uncertainty = ... % **[1]**

(iii) Suggest one procedural error that could result in the student's value being higher than the accurate value of 97.1.

....

.... **[1]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

Oxford Cambridge and RSA

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Insert

Practice paper – Set 2

Time allowed: 1 hour 30 minutes

INSTRUCTIONS

- Do not send this Insert for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

INFORMATION

- This document consists of **4** pages. Any blank pages are indicated.

Sulfamic acid in limescale remover

Limescale can be removed from electric kettles using a dilute solution of sulfamic acid.

In 'Part A' a student describes an investigation to determine the concentration of a solution of sulfamic acid in a commercial limescale remover.

In 'Part B' the student describes an experiment to determine the molecular mass of sulfamic acid.

Part A: Determining the concentration of a solution of sulfamic acid in a commercial limescale remover

Research told me that sulfamic acid was a monobasic acid and could be represented by the general formula 'HA'.

This means the concentration of the acid can then be determined by volumetric analysis using a standard solution of 0.10 mol dm^{-3} sodium hydroxide solution.

The equation for the reaction can be represented as:

$$HA(aq) + NaOH(aq) \rightarrow NaA(aq) + H_2O(l)$$

Preparing the 0.10 mol dm^{-3} standard solution of sodium hydroxide.

Method

1. Weigh 4.0 g of sodium hydroxide pellets into a weighing bottle (this should be done quickly to avoid the absorption of water from the atmosphere).

2. Transfer the sodium hydroxide into a beaker of 250 cm^3 capacity containing distilled water. Now carefully wash out the weighing bottle with a jet of distilled water and allow the washings to drop into the beaker. Use the glass stirring rod to stir the solution carefully to ensure that all the solid sodium hydroxide dissolves.

3. Transfer the solution into a 1 dm^3 volumetric flask, using a glass funnel, containing about 500 ml of distilled water. Use distilled water to rinse the inside of the beaker and the glass stirring rod at least twice and pour the washings into the volumetric flask.

4. Shake the flask gently. Fill it up with distilled water until it is close to the actual mark, then add more distilled water drop by drop after removing the funnel and rinsing it properly until the lowest level of the meniscus is on the mark when at eye level.

5. Stopper the flask and invert it several times. The solution prepared is 0.10 mol dm^{-3} sodium hydroxide.

Determining the concentration of sulfamic acid in the sample.

Method

1. Use a volumetric pipette to transfer 25 cm^3 of the commercial sulfamic acid solution into a 250 cm^3 volumetric flask.
2. Top up with distilled water until the volume of solution at the lowest level of the meniscus is on the 250 cm^3 mark when at eye level.
3. Use a new pipette to transfer 25 cm^3 of the diluted product from the volumetric flask into a conical flask.
4. Add a few drops of the phenolphthalein indicator provided.
5. Add the standard solution of sodium hydroxide, from a burette, until the indicator turns pink.
6. Repeat the titration until two concordant readings are obtained.

Results

Titration number	**1(rough)**	**2**	**3**	**4**
Final burette reading / cm^3	22.80	46.00	23.55	23.80
Initial burette reading / cm^3	0.00	22.80	0.00	0.00
Titre value / cm^3	22.80	23.20	23.55	23.80

At this point I decided there must be a problem with the sulfamic acid solution and so I asked the laboratory technician to prepare me a new solution of the sulfamic acid. The results of my titration with the new solution are below.

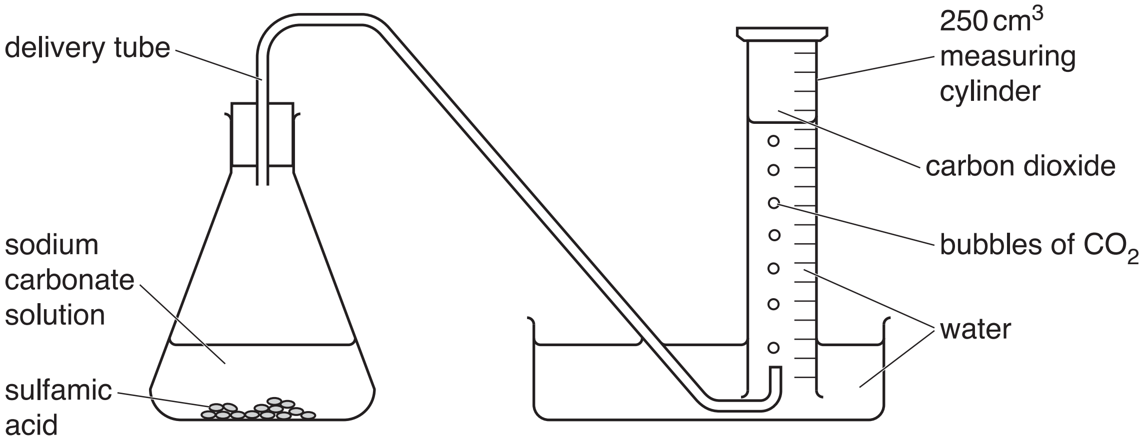
Titration number	**1(rough)**	**2**	**3**	**4**
Final burette reading / cm^3	22.00	43.80	21.65	43.45
Initial burette reading / cm^3	0.00	22.00	0.00	21.60
Titre value / cm^3	22.00	21.80	21.65	21.85

Part B: **Determining the molecular mass of sulfamic acid**

Method

I used the following apparatus to measure the volume of carbon dioxide gas evolved when a weighed sample of solid sulfamic acid was added to 100 cm^3 of a 0.50 $mol\,dm^{-3}$ solution of sodium carbonate.

Diagram



Results

Mass of conical flask and solid sulfamic acid / g	131.46
Mass of conical flask empty / g	130.26
Volume of carbon dioxide collected / cm^3	146

END OF PRACTICAL INSERT