

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Practice paper – Set 1

Time allowed: 1 hour 30 minutes



You must have:

- the Insert (inserted)
- the Data Sheet for Chemistry B (Salters)

You may use:

- a scientific 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.

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Answer **all** the questions.

- 1 A student carries out an experiment to compare the smells of different esters. The student follows the procedure given below.

- Prepare some small test-tubes by adding one drop of concentrated sulfuric acid to each.
- Add 10 drops of a carboxylic acid to the sulfuric acid in one test-tube.
- Add 10 drops of an alcohol to the mixture.
- Carefully lower the tube into a beaker of hot water.
- After 1 minute remove the tube and, when cool, pour the mixture into a boiling tube half-full of sodium carbonate solution.
- Smell the product by gently wafting the odour towards your nose with your hand.
- Repeat this procedure with different combinations of carboxylic acid and alcohol.

- (a) (i) What is the purpose of adding concentrated sulfuric acid to each tube?


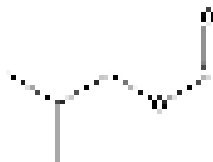
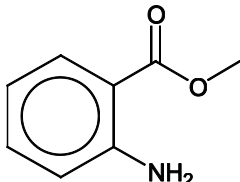
..... [1]

- (ii) Why is the mixture poured into the boiling tube of sodium carbonate solution and describe the expected observation.

.....
 [1]

- (b) The student uses various combinations of alcohol and carboxylic acid. These are shown in the table below with the smell of the ester formed.

Complete the table below by filling in the blanks.

Alcohol	Carboxylic acid	Structure of Ester	Smell
pentan-1-ol	ethanoic acid		pears
3-methylbutan-1-ol			bananas
2-methylpropan-1-ol	Methanoic acid		raspberry
	anthranilic acid		grape

[3]

- (c) The student tries to distil off some pure raspberry ester as its boiling point is lower than either reactant.

The student repeats the procedure with a larger quantities of reactants. After adding the sodium carbonate the student:

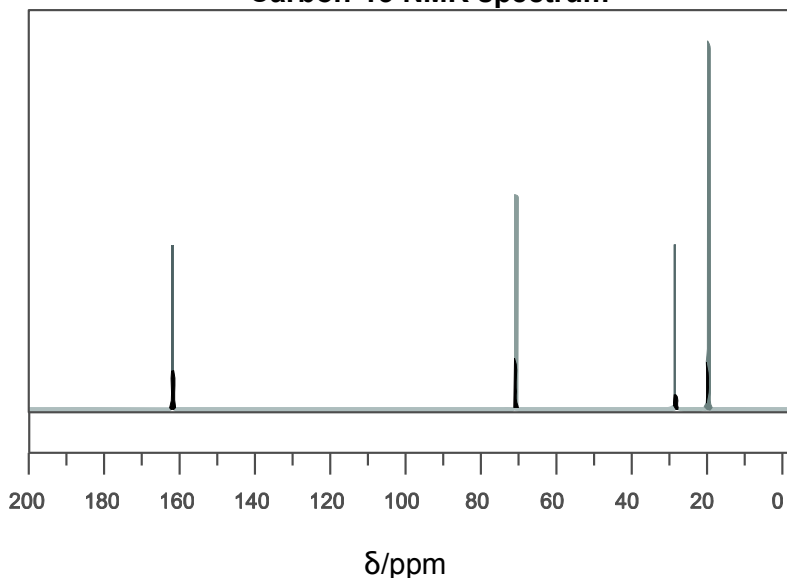
- puts the reaction mixture into a separating funnel and runs off the bottom aqueous layer
- swirls the top ester layer with anhydrous sodium sulfate for 20 minutes
- distils the mixture, collecting the ester.

- (i) State the role of the anhydrous sodium sulfate.

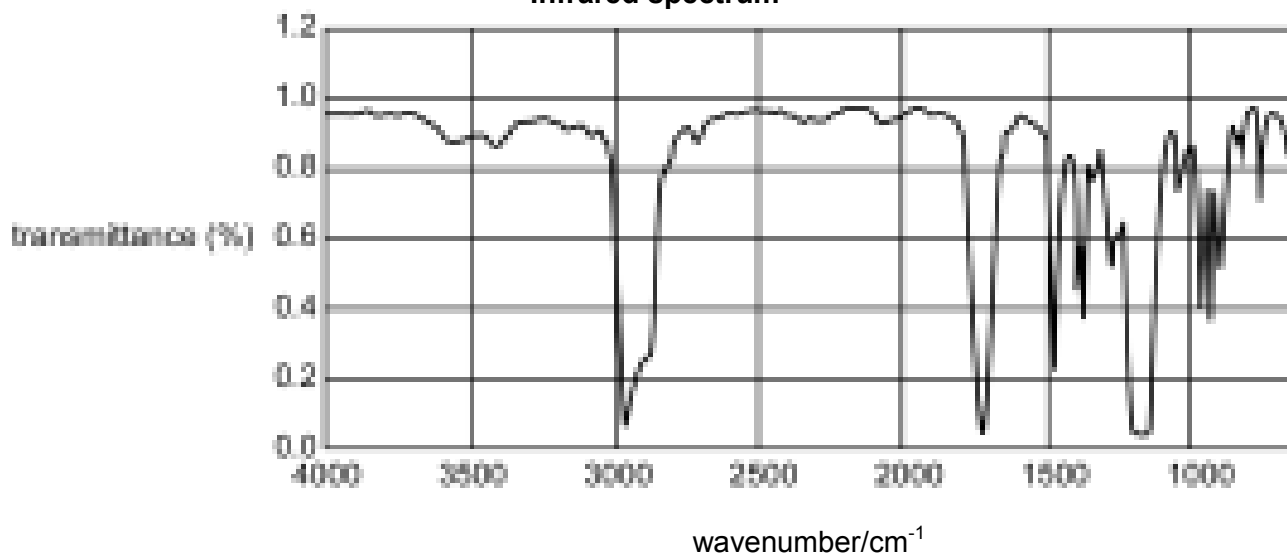
.....[1]

- (ii)* The student gets a local laboratory to run a carbon-13 NMR and an infrared spectrum on the product to confirm whether the preparation had produced the pure raspberry ester.

Carbon-13 NMR spectrum




Infrared spectrum



You may do rough working on this page but it will not be marked.

Some information from the table on page 3 is re-printed here.

Alcohol	Carboxylic Acid	Structure of Ester	Smell
2-methylpropan-1-ol	Methanoic acid		raspberry

Use information from both spectra to explain why they show that the distillation produced the pure raspberry ester.

[6]

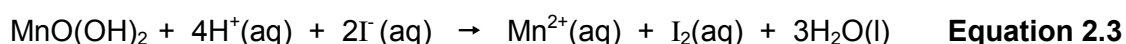
- 2 Water purity is an important environmental concern.
In general, high concentrations of dissolved oxygen indicate a low level of water pollution.

The 'Winkler' method, based on redox reactions, can be used to calculate the amount of dissolved oxygen in water.

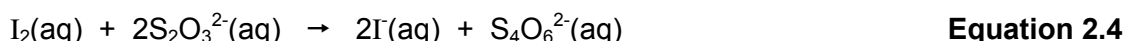
- (a) An environmental laboratory uses the 'Winkler' method to measure the amount of dissolved oxygen in a sample of treated water.

Manganese(II) sulfate, potassium iodide and acid can be added to the water sample and the liberated iodine is titrated with thiosulfate.

The key reactions (labelled **Equations 2.1 to 2.4**) in the Winkler method are shown below:



.....



- (i) **Equation 2.1** does **not** represent a redox reaction.
Name the **type** of reaction represented by **Equation 2.1**.

..... [1]

- (ii) Write the oxidation states of Mn and I on the dotted answer lines below
Equation 2.3. [2]

- (b) A 50 cm³ sample of water at 293 K was tested.
It was found that 10.50 cm³ of a 2.5 × 10⁻³ mol dm⁻³ solution of thiosulfate was required to react with the iodine produced in **Equation 2.3**.

- (i) State the indicator you would use, and the colour change you would see in this titration.

.....
..... [2]

- (ii) Determine the concentration of dissolved oxygen in the water sample.
Give your answer to an **appropriate** number of significant figures.

concentration =mol dm⁻³ [4]

- (iii) The concentration of dissolved oxygen in water is more commonly expressed in parts per million, ppm, by mass.

The maximum solubility of oxygen in water at 293 K is 2.8×10^{-4} mol dm⁻³.

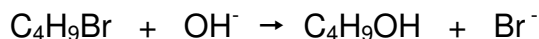
Calculate this concentration in ppm.

You may assume the density of water is 1.0 g cm⁻³.

concentration =ppm [2]

- 3 A group of students set out to investigate the rate of hydrolysis of 1-bromobutane. The reaction is relatively slow with water but much quicker with hydroxide ions (OH^-).

1-bromobutane reacts with sodium hydroxide solution as follows:



- (a) (i) Name the mechanism of this reaction.

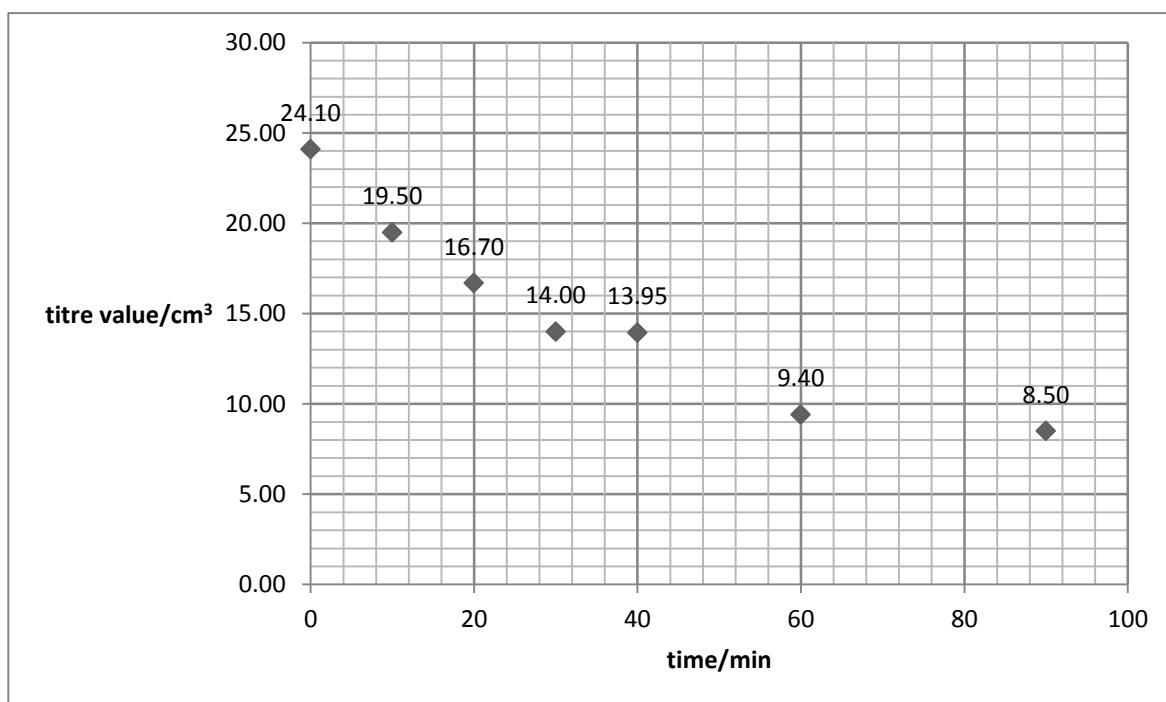
.....[2]

- (ii) Name the **type** of bond fission occurring in this reaction.

.....[1]

- (b) Equimolar quantities of 1-bromobutane and sodium hydroxide are mixed at 40°C .

The concentration of hydroxide ions is determined at various times by removing 10.0 cm^3 of the mixture, adding it to 20 cm^3 of iced water in a conical flask, and titrating with a 0.125 mol dm^{-3} solution of hydrochloric acid. The group's results are plotted below.



- (i) Suggest why the reactant mixture was added to a larger volume of iced water.

.....[1]

- (ii) Use the information given and the data on the graph to calculate the initial concentration of the sodium hydroxide solution.

initial concentration =mol dm⁻³ [2]

- (iii) Further investigations by the group suggested that the reaction was second order **overall**.

Write **two** rate equations which would be consistent with this suggestion.

rate =

rate = [1]

- (iv) Use the graph to calculate the initial rate of reaction, in mol dm⁻³ min⁻¹.

Show on the graph how you calculated the initial rate.

rate = mol dm⁻³ min⁻¹ [3]

- (v) Use the initial rate, along with your answer to (ii) above, to calculate the value of the rate constant, k , including the units, for this reaction at 40°C.

rate constant, k = units..... [2]

- (c)*** The students decide to extend their investigation to compare the rate of hydrolysis of 1-chlorobutane, 1-bromobutane and 1-iodobutane at a temperature of 60°C.

Describe and explain how they can use aqueous silver nitrate in their investigation, and what conclusions they should be able to make.

[6]

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

- (a) (i) Explain why different numbers of drops of water are added to the wells in the preliminary experiment.

.....
 [1]

- (ii) The pale blue precipitate formed in wells A3 and A4 is copper hydroxide.

Write an ionic equation for the reaction that forms the precipitate.
 Include state symbols.

[2]

- (iii) The pale blue precipitate dissolves when more ammonia solution is added because the reaction produces a soluble, deep blue complex ion.

This ion can be represented as $[\text{Cu}(\text{NH}_3)_x]^{2+}(\text{aq})$, where x is a whole number and the ammonia molecules are acting as ligands.

Name the bonds between the ammonia molecules and the central copper ion.

..... [1]

(b) In the main experiment:

- (i) What would be a suitable piece of apparatus to measure the volumes of the solutions shown in the table in the main experiment on page 3 of the Insert?

..... [1]

- (ii) A filter with the complementary colour to the solution being tested would be suitable for the experiment. However, the student was unsure which of the filters represented this complementary colour.

Explain how the filters could be tested to see which was the appropriate complementary colour.

.....

 [2]

- (iii) The ammonia solution was made up by dilution from a more concentrated stock solution.

Describe how the student could make up 250 cm³ of a 0.100 mol dm⁻³ solution of ammonia, from a stock solution of concentration 0.500 mol dm⁻³.

[3]

- (c) Use the graph paper below to plot a graph of the results from page 4 of the Insert. This should enable you to find the maximum whole number ratio of the volume of the copper ion solution to ammonia solution.

Use your graph to suggest the formula of the copper-ammonia complex ion.

formula of the copper-ammonia complex ion..... [5]

- (d) The student noticed that 'in the main experiment' no precipitate formed in any of the mixtures. The student assumed this was due to the presence of the ammonium sulfate.

Some of the ammonia molecules that dissolve in water to form ammonia solution react with water as shown in the equilibrium reaction below:



Use your knowledge of chemical equilibrium to suggest why the presence of the ammonium sulfate prevents a precipitate from forming.

.....

.....

.....

.....

.....

.....

.....

..... [4]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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

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A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Insert

Practice paper – Set 1

Time allowed: 1 hour 30 minutes



INSTRUCTIONS

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INFORMATION

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Finding the formula of a complex ion

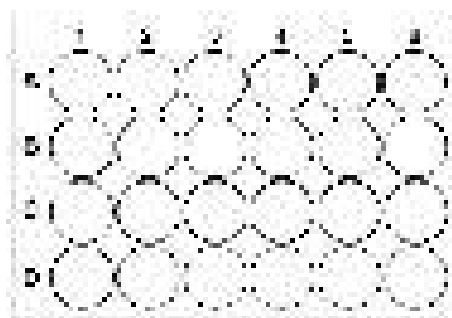
A student describes below an investigation to find the formula of a complex ion.

- Research told me it was possible to work out the formula of the complex ion formed from copper(II) ions and ammonia by mixing different proportions of them. The mixture with the most intense deep blue colour indicates the proportions of Cu^{2+} and NH_3 in the complex ion.
- After a preliminary experiment using well plates I then did a more accurate larger scale version, as my main experiment, using a colorimeter.

Preliminary experiment

Method

- Using a well plate (see diagram), place 4 drops of 0.1 M copper sulfate solution into each of wells A1 to A6.



well plate

- Add 1 drop of 0.1 M ammonia solution (ammonium hydroxide solution) to well A2, 2 drops to well A3, and so on until 5 drops are added to well A6. See table below.
- Add 6 drops of distilled water to well A1, 5 drops to well A2, and so on ending with 1 drop added to well A6. See table below.

Well	Drops of copper sulfate soln.	Drops of ammonia soln.	Drops of distilled water
A1	4	0	6
A2	4	1	5
A3	4	2	4
A4	4	3	3
A5	4	4	2
A6	4	5	1

- Stir each well.
- Note and record the observations for the reaction in each well.

Observations

Well	Observations
A1	blue solution
A2	slightly cloudy pale blue solution
A3	pale blue precipitate
A4	pale blue precipitate
A5	deep blue solution
A6	deep blue solution

Main experiment**Method****Chemical requirements**

2.0 mol dm⁻³ ammonium sulfate solution

0.1 mol dm⁻³ copper sulfate solution

0.1 mol dm⁻³ ammonia solution

1. Prepare a different mixture in 8 test-tubes by adding the volumes of the three solutions shown in the table below.
2. Cork each tube and shake to mix thoroughly.
3. Transfer the solution to the cuvettes fitting into the colorimeter.

Test-tube number	1	2	3	4	5	6	7	8
Volume of ammonium sulfate solution/cm ³	5	5	5	5	5	5	5	5
Volume of copper sulfate solution/cm ³	0.0	1.0	1.5	2.0	2.5	3.0	4.0	5.0
Volume of ammonia solution/cm ³	10.0	9.0	8.5	8.0	7.5	7.0	6.0	5.0
Colorimeter absorbance reading(arbitrary units)	0.0							

4. Choose a suitable filter for this experiment.
5. Zero the colorimeter using tube 1.
6. Immediately after setting the colorimeter to zero with tube 1, replace it with tube 2 and take a reading of the absorbance.
7. Repeat step 3 before taking further colorimeter readings for each of the remaining test-tubes in turn.

Results from main experiment

Test-tube number	1	2	3	4	5	6	7	8
Volume of ammonium sulfate solution/cm ³	5	5	5	5	5	5	5	5
Volume of copper sulfate solution/cm ³	0.0	1.0	1.5	2.0	2.5	3.0	4.0	5.0
Volume of ammonia solution/cm ³	10.0	9.0	8.5	8.0	7.5	7.0	6.0	5.0
Colorimeter absorbance reading(arbitrary units)	0.0	0.20	0.29	0.34	0.32	0.28	0.22	0.15

END OF PRACTICAL INSERT

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