OCR
Oxford Cambridge and RSA

Wednesday 19 June 2019 – Morning

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Time allowed: 1 hour 30 minutes

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

You may use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) ______________________

Last name ______________________

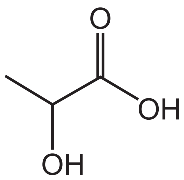
INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- The practical insert is needed with this paper.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- 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.

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 **20** pages.

Answer **all** the questions.

1 A student taking A level chemistry and biology was researching the use of polymers in medicine. These are sometimes called biopolymers.

The student found that one of the most frequently used biopolymers is polylactic acid, PLA. PLA is made from lactic acid.



Lactic acid

(a) Lactic acid is a chiral molecule.

Explain the term **chiral** in this context and use 3-D structures to help your explanation.

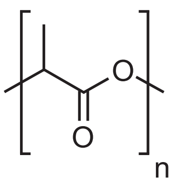
Explanation ....

....

Structures

[3]

(b) The structure of PLA is shown below.



PLA

PLA has a wide variety of uses. One use is in biodegradable medical devices (e.g. screws and plates that are expected to biodegrade within 6–12 months).

(i) Name the functional group in PLA and suggest the **type** of reaction that occurs when PLA biodegrades.

....

.... **[2]**

(ii) State the strongest type of intermolecular bonding that occurs between PLA polymer chains.

Explain, in terms of electronegativity, how this intermolecular bonding arises.

....

....

....

.... **[2]**

(c) The industrial manufacture of PLA uses heterogeneous catalysts.

A simple model of heterogeneous catalysis has four steps.

Describe the four steps involved.

1 ....

....

2 ....

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3 ....

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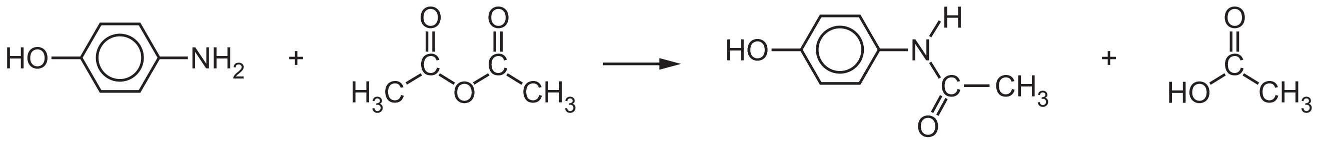
4 ....

....

[2]

2 A pair of chemistry students are asked to prepare a sample of paracetamol.
They use the reaction shown in **Fig. 2.1**.



4-aminophenol | ethanoic anhydride | paracetamol | ethanoic acid

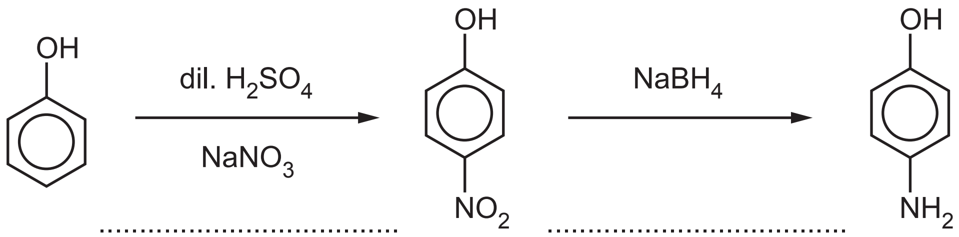
Fig. 2.1

(a) Identify the **two** functional groups in paracetamol, apart from the benzene ring.

1 ....

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

(b) The reactant 4-aminophenol can be made from phenol in the two-step synthesis shown below.



Name the **type** of reaction for each step.

Write your answers on the dotted lines. **[2]**

(c) **Fig. 2.2** shows some information found on a bottle of ethanoic anhydride.

The students use the information in **Fig. 2.2** to write a risk assessment for ethanoic anhydride.

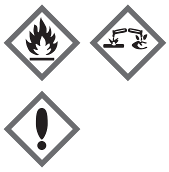
Ethanoic anhydride	**Hazards**
	Flammable Harmful by inhalation and if swallowed Corrosive – causes burns

Fig. 2.2

Suggest **three** precautions that the students should take when using ethanoic anhydride.

1 ....

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2 ....

....

3 ....

.... **[3]**

(d) The mechanism for the reaction for the formation of paracetamol is shown in **Fig. 2.3**.

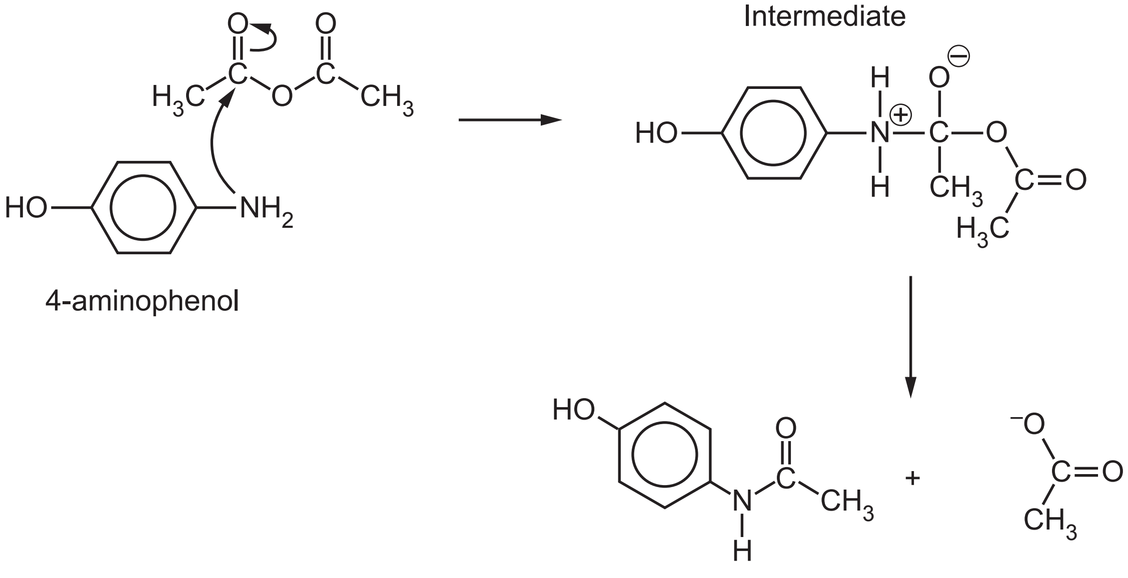

Fig. 2.3

Mark curly arrows to show the electron movements that occur in the **intermediate** to allow formation of the products in **Fig. 2.3**. **[1]**

(e) The students carry out the preparation using water as solvent. Paracetamol is insoluble in water.

The students use the apparatus in **Fig. 2.4** to separate the paracetamol from the reaction mixture.

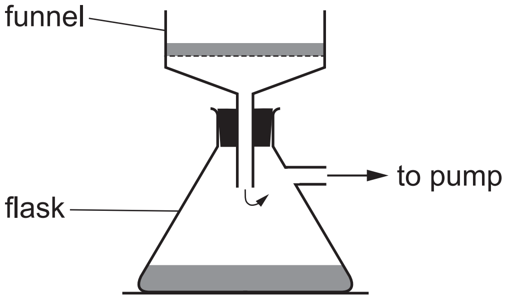

Fig. 2.4

(i) Name the technique in **Fig. 2.4** and explain how this apparatus is used to get a sample of impure solid paracetamol.

....

....

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....

....

.... **[3]**

(ii) Suggest a reason for using the technique in **Fig. 2.4** rather than simple filtration.

....

.... **[1]**

Fig. 2.1 is repeated below.

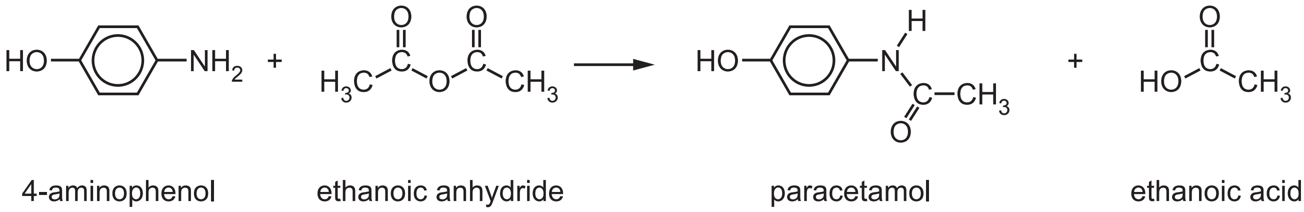


Fig. 2.1

(f) The students then recrystallised their paracetamol sample.

The students started with a mass of 2.1 g of 4-aminophenol and used excess ethanoic anhydride.

The mass of the dried recrystallised paracetamol produced was 1.5 g.

Calculate the percentage yield for the students' reaction.

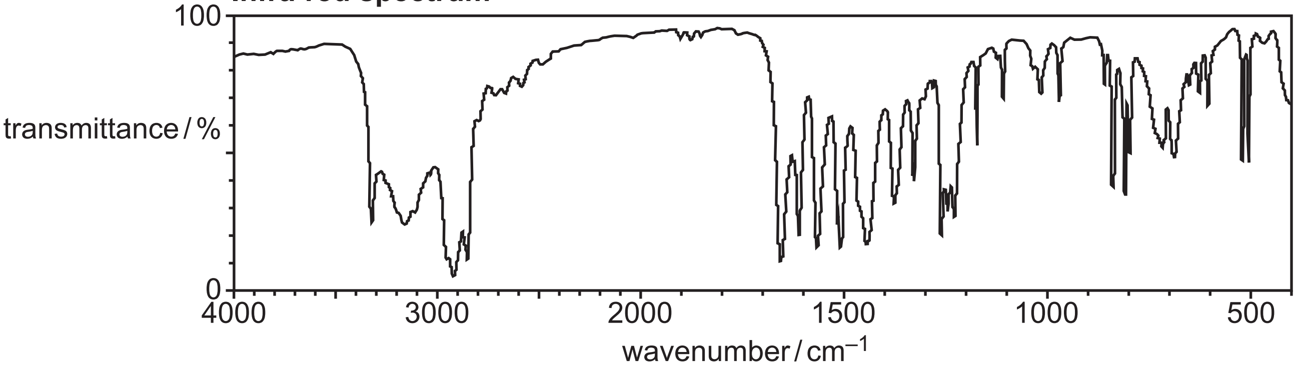
Give your answer to an **appropriate** number of significant figures.

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

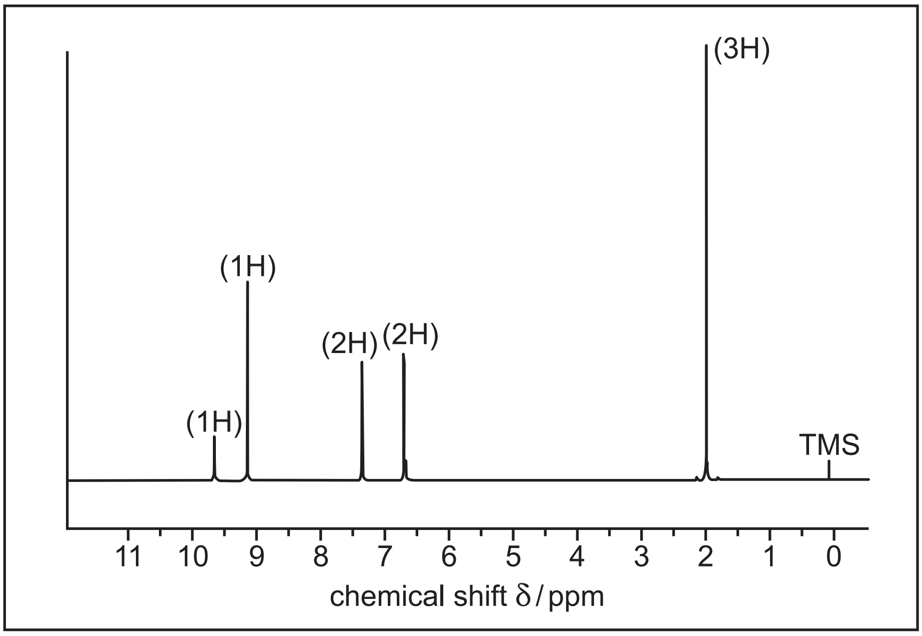
(g) The students sent pure samples of their reagents and products to a university lab. Spectra of all the compounds were produced.

The spectra from **one** of the compounds are shown below.

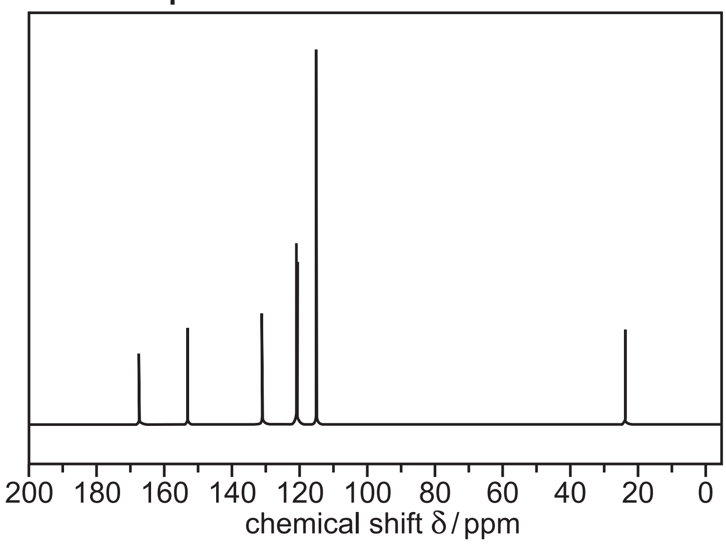
Infra-red spectrum



Proton NMR spectrum



^{13}C NMR spectrum



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

Use pieces of evidence from **all** the spectra to identify the compound. **[6]**

Additional answer space if required

(h) The mass spectrum of ethanoic acid is shown below.

Mass Spectrum

(i) Give the structures that produce the peaks at:

60 ....

43 ....
[2]

(ii) Suggest why there is a small peak at 61.

....

.... **[1]**

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3 A group of students are investigating the properties of weak acids and buffer solutions.

They take measurements of the pH of some solutions before and after adding an equal volume of 0.01 mol dm^{-3} sodium hydroxide solution.

Some of the students' results are shown in the table below.

Experiment	Original solution	pH before addition	pH after addition
A	0.01 mol dm^{-3} ethanoic acid	3.4	8.2
B	0.1 mol dm^{-3} ethanoic acid plus an equal volume of 0.1 mol dm^{-3} sodium ethanoate	4.8	4.9
C	0.1 mol dm^{-3} sodium ethanoate	8.9	11.7
D	Distilled water	7.0	

(a) The solution in experiment **B** is behaving as a buffer solution.

Explain the meaning of the term **buffer solution**.

....

....

....

.... **[2]**

(b) K_a for ethanoic acid is 1.7×10^{-5} mol dm^{-3}.

Show by calculation that the initial pH in experiment **B** is 4.8.

[2]

(c) Explain why the pH of sodium ethanoate in experiment **C** is alkaline.

Include an equation in your answer.

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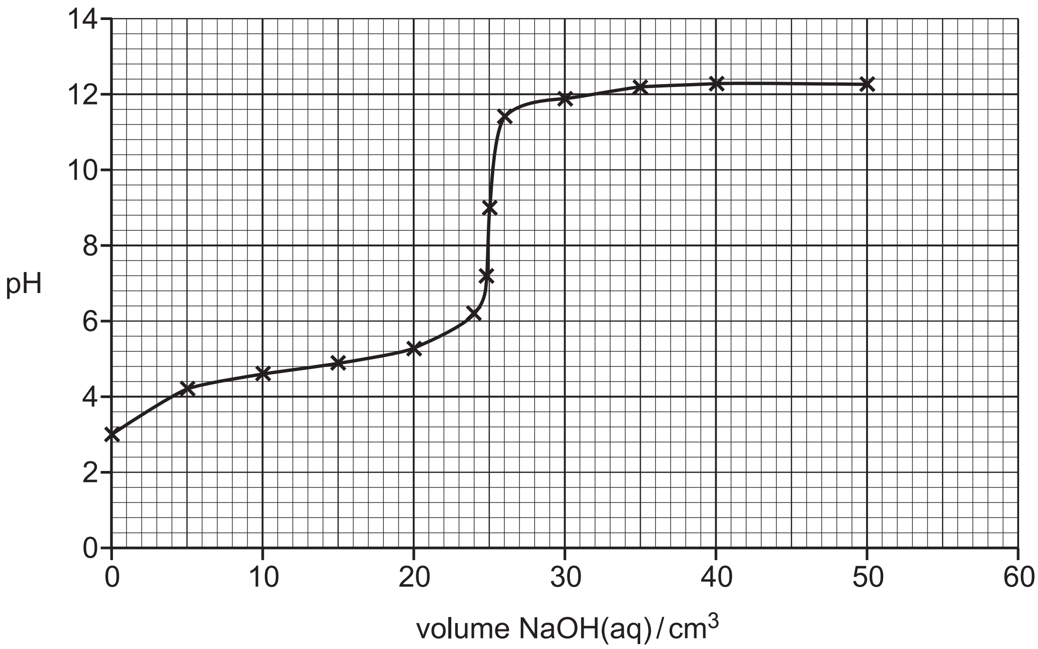
.... **[2]**

(d) Calculate the pH of the solution formed after the addition of sodium hydroxide solution in experiment **D**.

pH = ... **[3]**

(e) In a follow-up experiment, 25.0 cm^3 of the ethanoic acid solution is titrated with a solution of sodium hydroxide of unknown concentration and the following graph is obtained.



Suggest a suitable practical procedure that would enable this graph to be obtained.

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....

.... **[3]**

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

(a) Suggest why the titre values in **Table 2** increase from sample 1 to sample 4.

....

.... **[1]**

(b) The students use a titre value of 8.00 cm^3 to calculate the mass of iron in the spinach in sample 4.

(i) Show how the students calculated the value of 8.00 cm^3 as their titre for the calculation.

.... **[1]**

(ii) Foods 'high' in iron usually contain more than 4 mg of iron per 100 g of foodstuff.
A student states that the data in **Tables 1** and **2** show that spinach is 'high in iron'.

Comment on the student's statement.

Show calculations to support your comments, using the data for **sample 4**.

....

....

....

.... **[4]**

(c) A student suggests that the titre values in the experiment are too small and give an unacceptable error for the final answer.

(i) Calculate the percentage uncertainty in titre 1 for **sample 4**.

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

(ii) The students want to reduce the percentage uncertainty in the titre values, while using the same equipment.

Suggest **two** ways in which they can do this.

1 ....

....

2 ....

.... **[2]**

(d)* There are several d block metal ions, including complex ions, mentioned in the insert. These ions are different colours.

Explain the term **complex ion** and why different complexes of d block elements have different colours.

Give examples from the Insert. **[6]**

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Additional answer space if required

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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).

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Wednesday 19 June 2019 – Morning

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Practical Insert

Time allowed: 1 hour 30 minutes

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INSTRUCTIONS
- Do not send this insert for marking; it should be retained in the centre or destroyed.

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

Iron in spinach

Spinach has often been regarded as an excellent source of dietary iron.

Below a student describes an investigation to determine the mass of iron contained in a typical portion of spinach used in a meal.

Introduction

The amount of iron, as Fe^{2+}, in spinach can be found by titration with potassium manganate(VII) solution.

Manganate(VII), MnO_4^-, is a strong oxidising agent. It accepts electrons easily, and is reduced to colourless manganese(II) ions according to the half-equation below:

$MnO_4^-(aq)$ + $8H^+(aq)$ + $5e^-$ → $Mn^{2+}(aq)$ + $4H_2O(l)$
(purple) (colourless)

The electrons are provided by reducing agents such as iron(II) salts:

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

As a result, manganate(VII) can be used in acidic solution to determine the number of moles of reducing agent, e.g. Fe^{2+}, present.

Manganate(VII) is added from a burette to a solution of Fe^{2+} ions and is decolourised immediately. As soon as the Fe^{2+} ions are used up, the next drop of manganate(VII) is not decolourised, and so the solution in the conical flask goes pale pink. The end-point of the titration is the first permanent appearance of this pale pink colour. Manganate(VII) is therefore self-indicating and no other indicator is needed.

The acid used to provide $H^+(aq)$ is dilute sulfuric acid; this should always be in excess or else insoluble brown MnO_2 will form.

Getting the Fe^{2+} ions into solution

Approximately 5 g portions of spinach were immersed in dilute sulfuric acid for various amounts of time. The solutions were filtered and 25 cm^3 portions were titrated with the standard potassium manganate(VII) solution.

Method

1. Four samples of approximately 5 g of the spinach leaves provided were weighed by difference, accurately, using a 2 decimal place balance. All the weighings were recorded.

2. Each weighed sample of spinach was added to about 100 cm^3 of sulfuric acid in a beaker and allowed to stand for various amounts of time.
After standing each sample was filtered into a 250 cm^3 volumetric flask. The original beakers were washed several times with de-ionised water and the washings transferred to the flask. The solution was made up to the mark with de-ionised water.

3. 25 cm^3 of one of the solutions was pipetted into a conical flask.

4. The above solution was titrated against a 5.0×10^{-6} mol dm^{-3} solution of $KMnO_4$ from a burette until at least two concordant results were obtained.

5. Steps 3, 4 and 5 were repeated with each of the sample solutions.

Results and Analysis

Weighings

	Mass of weighing boat / g	Mass of spinach + weighing boat / g	Mass of spinach / g
Sample 1	1.43	6.75	5.32
Sample 2	1.43	6.98	5.55
Sample 3	1.43	6.40	4.97
Sample 4	1.43	6.53	5.10

Table 1

Titrations

		Sample 1	Sample 2	Sample 3	Sample 4
	Time / mins	**30**	**60**	**90**	**120**
Rough titre	**Initial vol / cm^3**	0.00	0.00	0.00	0.00
	Final vol / cm^3	6.80	7.25	7.70	8.20
	Titre / cm^3	6.80	7.25	7.70	8.20
Titre 1	**Initial vol / cm^3**	7.00	8.00	8.00	10.00
	Final vol / cm^3	13.80	15.10	15.55	18.05
	Titre / cm^3	6.80	7.10	7.55	8.05
Titre 2	**Initial vol / cm^3**	15.00	16.00	16.00	20.00
	Final vol / cm^3	21.75	23.15	23.50	27.95
	Titre / cm^3	6.75	7.15	7.50	7.95

Table 2