OCR
Oxford Cambridge and RSA

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Tuesday 27 June 2017 – Morning

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

First name	
Last name	
Centre number	
Candidate number	

INSTRUCTIONS
- The Insert will be found inside this document.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- The practical insert is needed with this paper.
- 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, you should 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.

Turn over

Answer **all** the questions.

1 A group of students decide to analyse a commercial sweetener.
The major component is listed as the dipeptide aspartame.

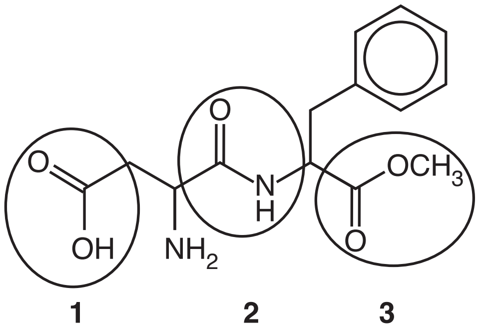
(a) The students crush a sweetener tablet and dissolve it in 1 cm^3 of water in a test tube.
They add a similar volume of 6.0 mol dm^{-3} hydrochloric acid and some anti-bumping granules.
They then cautiously boil the contents for about a minute.

Suggest the purpose of adding the anti-bumping granules.

.... **[1]**

(b) The students expect the aspartame to have been hydrolysed by the hot acid.

(i) The structure of aspartame is given below with three functional groups (**1**, **2**, **3**) ringed.



Name the homologous series for the functional groups **1**, **2** and **3**.

1 ....

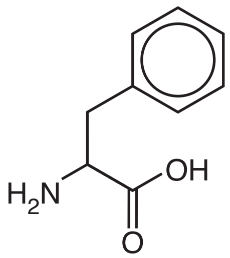
2 ....

3 .... **[1]**

(ii) Functional group 2 **and** functional group 3 are hydrolysed under the acid conditions to give three products. The products are methanol, and ions formed by the amino acids phenylalanine and aspartic acid.

The structure of the amino acid phenylalanine is given below.

In the box draw the structure of the **ion** formed by **aspartic acid**.



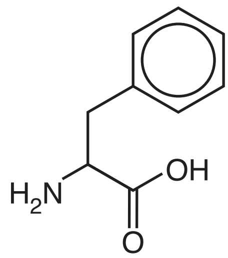
phenylalanine

structure of **ion** formed by aspartic acid

[2]

(iii) Amino acids such as phenylalanine exist as *zwitterions*.

Use the structure of phenylalanine to help explain how amino acids form zwitterions.
Draw the structure of the zwitterion of phenylalanine.



phenylalanine

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[2]

(c)* The students wanted to confirm that the aspartame had been hydrolysed to produce the two amino acids, aspartic acid and phenylalanine.

They decided the best way was to use paper chromatography on the solution formed after the hydrolysis reaction.

Describe how the students could carry out the chromatography experiment and explain how they could use their results to show hydrolysis had taken place.

You may include a diagram in your answer.

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.... **[6]**

(d) The students decided to investigate carbonated drinks such as diet and regular cola.
These drinks contain phosphoric acid (to increase the flavour) and aspartame.
Regular cola has a lower concentration of acid and keeps for longer than diet cola.

Suggest why regular cola keeps for longer.

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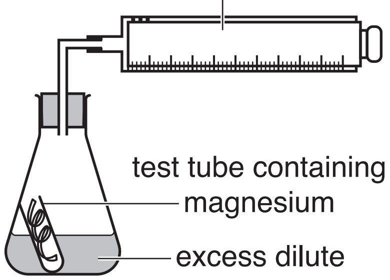
.... **[2]**

2 Two students decide to study the reaction of magnesium with dilute hydrochloric acid to find the order of this reaction with respect to the acid.

The equation for the reaction is:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

The students use the following apparatus:



(a) The students run **five** experiments each using a different concentration of hydrochloric acid.

They use the same length of magnesium ribbon each time.

(i) Why was the length of the magnesium ribbon kept the same?

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.... **[1]**

(ii) 50 cm^3 acid is used each time.
The concentration ranged from 0.1 to 0.5 $mol\,dm^{-3}$.

Calculate the **maximum** mass of magnesium ribbon that would completely react with the acid in **all** five experiments.

mass = ... g **[3]**

(iii) Calculate the maximum length of magnesium ribbon needed to completely react with the acid in all the experiments.

The mass per unit length of Mg ribbon = $1.3 \times 10^{-2}\,\text{g cm}^{-1}$

length = ... cm **[1]**

(b) The students predict that the reaction will be second order with respect to acid.

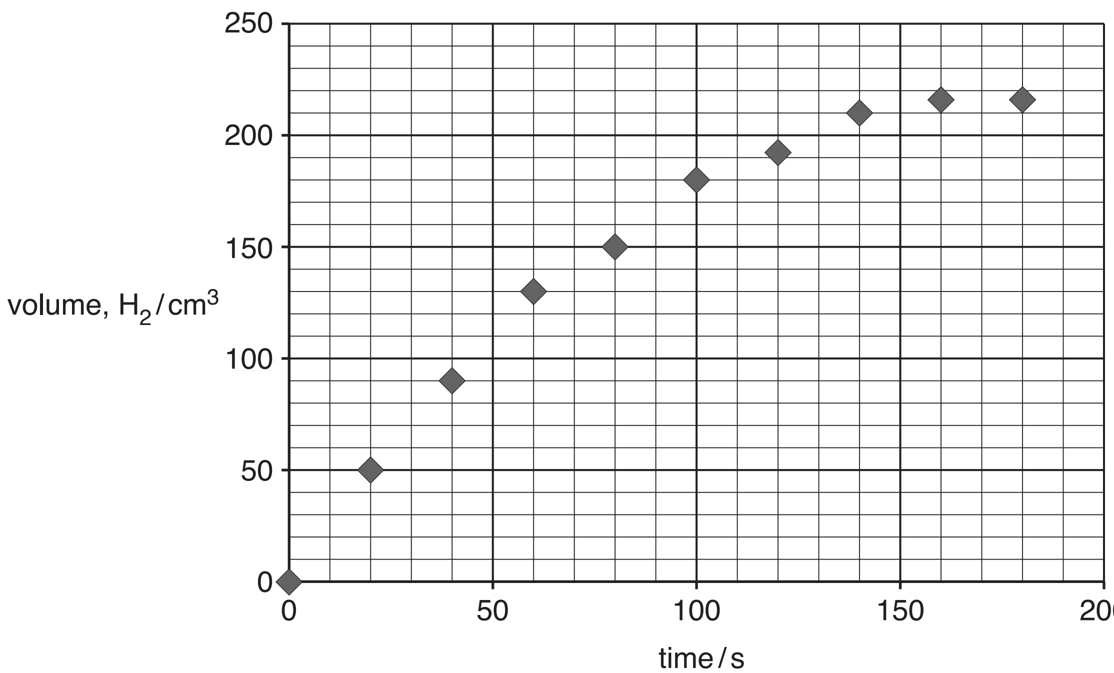
Write the rate equation that would be appropriate for this prediction.

.... **[1]**

(c) The students plot a graph of volume of hydrogen against time.
The graph of the results when the concentration of hydrochloric acid is 0.5 mol dm^3 is shown below.

Draw a line of best fit on the graph.
Use your line of best fit to calculate the initial rate of reaction at this concentration and give the units.

Show your working on the graph.



initial rate .... units .... **[5]**

(d) The students decide to measure the activation enthalpy for the reaction.
They repeat the experiment at different temperatures using a fixed concentration of acid.

The following table shows the data from their experiments.

ln *k*	**Temperature /°C**	**Temperature, *T*/K**	**$1/T$ / K^{-1} ($\times 10^{-3}$)**
–5.46	15.6	288.6	3.47
–4.92	30.3	303.3	3.30
–4.34	45.0	318.0	3.14
–3.73	65.0	338.0	2.96

Use the data to plot a suitable graph on page 9 and work out the activation enthalpy for the reaction.

activation enthalpy = ... kJ mol^{-1} **[6]**

3 A perfume laboratory is investigating the molecules responsible for the smell of some common flowers.

Their investigations suggest that the following two liquid compounds are important in the characteristic smell of hyacinth flowers.

ocimenol

cinnamyl alcohol

(a) Acidified dichromate solution can be used to distinguish between these two compounds. Only cinnamyl alcohol can be oxidised using acid dichromate.

Explain why this is so, and describe any colour changes you would expect to see.

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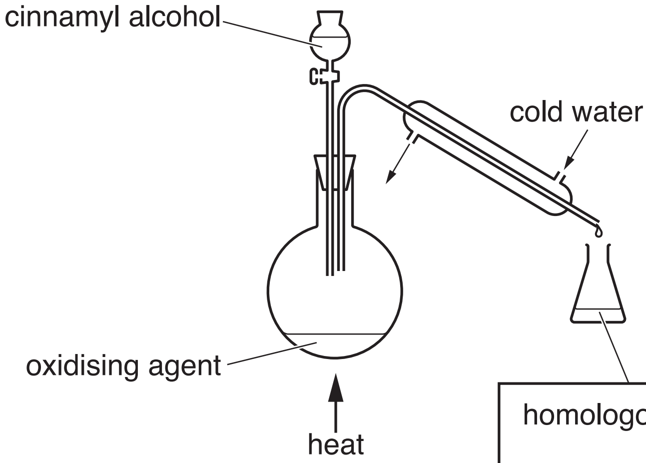
.... **[2]**

(b) The products of the oxidation of cinnamyl alcohol by acid dichromate differ depending on the conditions.
Two experiments are shown below.

Name, in the appropriate boxes below and on page 11:
- the technique used in each set up
- the homologous series of the final product of oxidation



technique used

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homologous series of product

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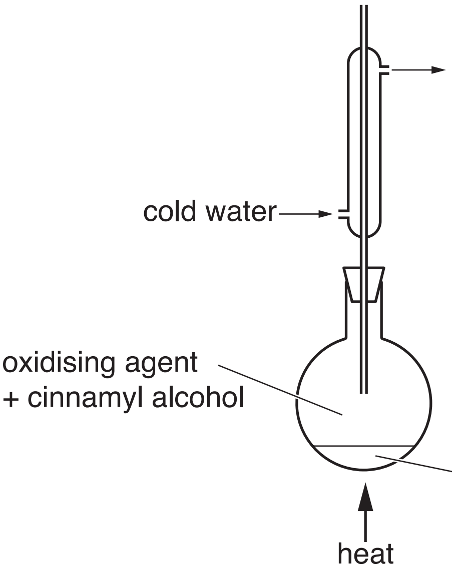

technique used

....

homologous series of product

....

[4]

(c) Ocimenol and cinnamyl alcohol are both unsaturated molecules.

Explain how you could use a solution of bromine water to show which of the molecules has the greater degree of unsaturation.

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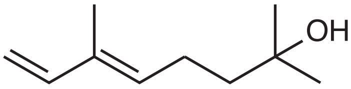
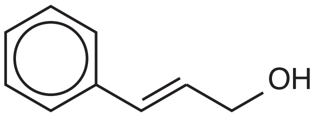
.... **[4]**

(d) Both ocimenol and cinnamyl alcohol molecules show stereoisomerism.



ocimenol



cinnamyl alcohol

- Name the **type** of stereoisomerism shown by these molecules.
- Explain how this isomerism arises.
- The structure of one of the stereoisomers of cinnamyl alcohol is shown in the left hand box below; draw the structure of the other isomer in the right hand box.

Type of stereoisomerism ....

Explanation

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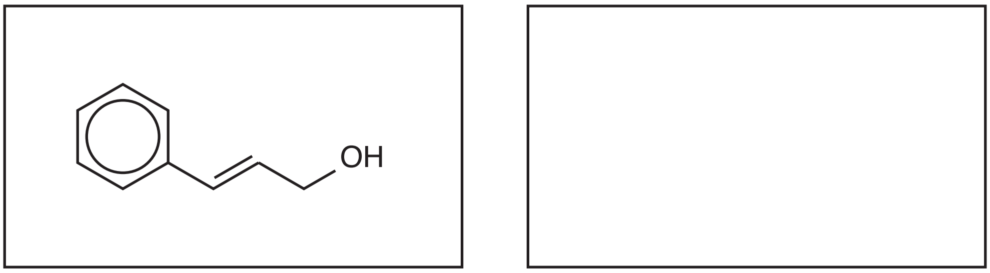

[3]

(e) Mass spectrometry can also be used to distinguish between ocimenol and cinnamyl alcohol. The molecular ion peak in a mass spectrum of ocimenol is at an *m/z* value of 154.

What *m/z* value would represent the molecular ion peak in a mass spectrum of cinnamyl alcohol?

m/z for cinnamyl alcohol molecular ion = ... **[1]**

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

4 (a) (i) Name the piece of apparatus which is most suitable for removing the 25.0 cm^3 of the Cu^{2+} ion solution.

.... **[1]**

(ii) Use the student's results in the *Practical Insert* to work out an average titre that the student should use in calculating the amount of Cu^{2+} in the 'coin solution'.

average titre = ... cm^3 **[1]**

(iii) Use your answer from **(a)(ii)** to calculate the percentage by mass of copper in the coin. Give your answer to an **appropriate** number of significant figures.

percentage by mass of copper in coin = ... % **[4]**

(iv) The student considers the uncertainties of measurement in the experiment.

The percentage measurement uncertainty marked on the apparatus used to transfer the 25 cm^3 of the 'copper' solution is ±0.24%.
The volumetric flask is marked ±0.08%.

Calculate the measurement uncertainties of the other pieces of apparatus used.
Which piece of apparatus contributes most to the measurement uncertainty in this experiment?

[2]

(v) Name another method that the student could use to find the concentration of Cu^{2+} ions in the 'coin solution'.

.... **[1]**

(b)* The student's method requires a standard solution of sodium thiosulfate for the titration.

Describe the techniques and procedures used to prepare a standard solution of a specific concentration from a solid.

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.... **[6]**

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

Practical Insert

Tuesday 27 June 2017 – Morning

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.

Fake coins

There has been concern about the number of fake coins in circulation.
Below a student describes an investigation to compare the amount of copper in various coins.

- **To find the amount of copper in the coins I decided to use a titration with sodium thiosulfate**
- **I need to dissolve a coin in nitric acid and then add excess iodide ion solution; the liberated iodine can then be titrated with the thiosulfate solution**
- **In a genuine one pence coin the percentage by mass of copper should be 96%.**

The relevant reactions are:

$$Cu(s) + 2NO_3^-(aq) + 4H^+(aq) \rightarrow Cu^{2+}(aq) + 2NO_2(g) + 2H_2O(l)$$

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$

(Note: the copper ions are produced in solution when the copper coin dissolves in the concentrated nitric acid)

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

Dissolving the coin

Weigh a penny coin on an electric balance, reading to two decimal places. Add the coin to excess concentrated nitric acid and warm in a fume cupboard.

After all the coin has dissolved allow the solution to cool and transfer carefully to a 250 cm^3 volumetric flask. Make the resulting solution up to the mark using distilled water.
Ensure the solution is thoroughly mixed by inverting the stoppered flask several times.

Determining the copper content of the coin

1. Take 25.0 cm^3 portions of the copper ion solution and transfer to a conical flask.
2. Neutralise excess acid by adding sodium carbonate solution in small volumes until any fizzing stops.
3. Add excess potassium iodide solution (about 25 cm^3 of approximately 1.0 $mol\,dm^{-3}$ solution).
4. Add a few drops of freshly prepared starch solution. The presence of the starch will cause the mixture in the flask to go black.
5. Titrate the liberated iodine with a standard solution of 0.200 $mol\,dm^{-3}$ sodium thiosulfate solution until all the iodine has reacted and the mixture in the flask goes white.
6. Repeat the titration until three concordant results are obtained.
7. Calculate the concentration of copper ions in the original copper ion solution and work out the percentage of copper in the coin.
8. Compare the percentage with data book values to decide whether the coin was a fake.

[Reference: Modified from Graham Hill, John Holman (2001): *Chemistry in Context, Laboratory Manual, Fifth Edition* Cheltenham, Nelson Thornes.]

Results

Mass of coin dissolved = 3.56 g

	Titration 1	Titration 2	Titration 3	Titration 4
Final burette reading / cm^3	22.85	45.45	22.55	45.20
Starting burette reading / cm^3	0.00	22.85	0.00	22.55

Comments on my experiments

The experiment seemed to go well.

My percentage value was lower than the suggested value of 96% copper. This could mean, either the coin was a fake, or possibly the errors in my experiment were more significant than I thought.

My procedure seemed to be sound, although I did notice that the standard solution of thiosulfate I had made up had gone a bit cloudy.

I calculated the errors due the measurements I took, to see if they were significant.

