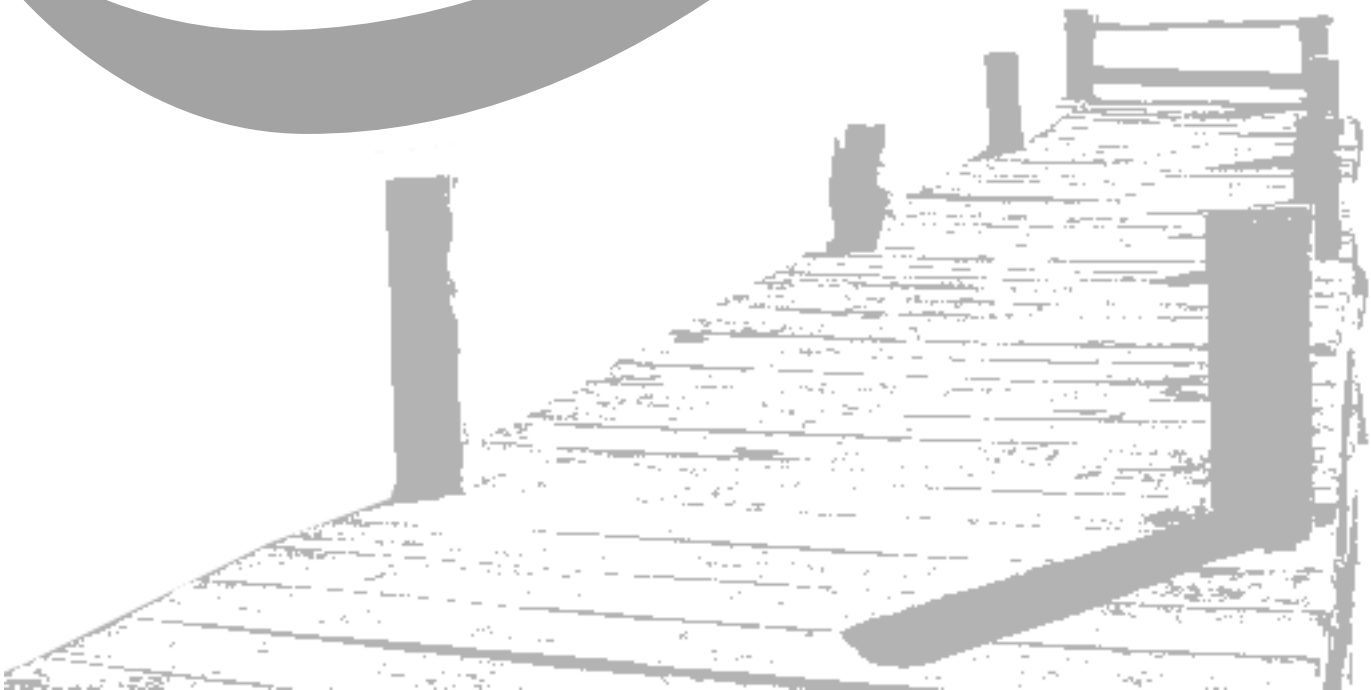
GCE
AS and A Level

Chemistry

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 3T: ISA
Specimen question paper

Version 1.2



Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

For Examiner's Use

General Certificate of Education
Advanced Subsidiary Examination

CHEMISTRY **CHM3T**
Investigative Skills Assessment (ISA)
Centre Assessed Unit

Draft Specimen Paper

In addition to this paper you will require
- task sheet and your candidate results sheet

You may use a calculator.

For Teacher's Use	
Section	Mark
1	
2	
TOTAL	

Time allowed: 1 hour

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 30.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.
- Use accurate scientific terminology in all answers.

Signature of Teacher marking this ISA…… Date…….

SECTION A

These questions are about the task, the M_r of sulfamic acid.
You should use the task sheet and your own results to answer them.
Full marks can only be scored in calculations if you show all of your working.

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

ANALYSING

1 Suggest why, in "a value for money" test of a range of cleaners, it is important to test samples from more than one bottle of each cleaner.

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(1 mark)

2 Use all of your concordant results to determine an average titre.

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(1 mark)

3 Representing the unknown acid as HA, the equation for the reaction with sodium hydroxide is shown below.

$$HA + NaOH \rightarrow NaA + H_2O$$

Use the average titre to calculate the concentration in mol dm^{-3} of the **diluted** acid.

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(1 mark)

4 Use your result from **Part 3** to determine the concentration in mol dm^{-3} of the **original** acid solution.

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(1 mark)

5 The manufacturer claimed that the concentration of the acid in the **original** solution of the cleaner was 100 g dm^{-3}. Use your result from **Part 4** to predict the M_r of the unknown acid.

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(1 mark)

6 Suggest **two** possible hazards faced by someone using an aqueous solution of an acid-based de-scaler.

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(2 marks)

7 The table below shows some information about three sulfamic acid based de-scalers.

De-scaler	**Sulfamic acid content** % by mass	**Price/100 cm^3** £
Dip-to-Clean	3.5	0.75
Clean It	1.5	0.40
Lose that Scale	9.8	2.20

Use the data in the table to determine which de-scaler offers the best value for money, based on sulfamic acid content.

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(1 mark)

8

SECTION B

Determination of the molecular formula of sulfamic acid.

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

INTRODUCTION

In **Section A** you determined the M_r of the acid present in a new household cleaner. Another chemist completed further tests on the unknown acid. Use your results, and the data from these further tests to confirm that the unknown acid is sulfamic acid.

ANALYSING Full marks can only be scored in calculations if you show all of your working.

1 Analysis of a pure sample of the unknown acid showed that it contained 14.42% of nitrogen, 3.09% of hydrogen and 33.06% of sulfur by mass, the rest being oxygen. Use these data to calculate the empirical formula of the acid.

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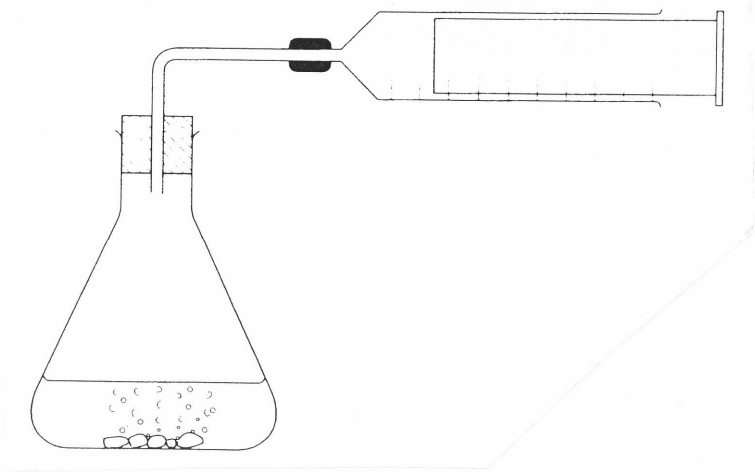
(2 marks)

2 The chemist then carried out an experiment to determine the M_r of sulfamic acid. The chemist set up the apparatus shown below.



A 1.60 g sample of pure sulfamic acid was dissolved in water and then transferred to the conical flask. An excess of magnesium ribbon was added to the flask and the bung was quickly replaced.

When the reaction was complete the volume of gas produced was then recorded.

Representing sulfamic acid as HA, the equation for the reaction with magnesium is shown below.

$$Mg + 2HA \rightarrow MgA_2 + H_2$$

The experiment was repeated with further 1.60 g samples of pure sulfamic acid. The chemist's results are shown below. All measurements were taken at 20 °C and a pressure of 9.95×10^4 Pa.

Experiment	1	2	3	4
Volume of hydrogen/cm^3	198	203	185	199

(a) Identify any anomalous results in the chemist's experiments and give a reason for your choice

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(2 marks)

(b) Calculate the average volume of hydrogen produced by 1.60 g of sulfamic acid at 20 °C and a pressure of 9.95×10^4 Pa.

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(1 mark)

(c) State the ideal gas equation.

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(1 mark)

(d) Use the ideal gas equation and your answer to **Part 2(b)** to predict the number of moles of hydrogen formed in the reaction at 20 °C and 9.95×10^4 Pa.

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(2 marks)

(e) Deduce the number of moles present in of 1.60 g of sulfamic acid.

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(1 mark)

(f) Use your answer to **Part 2(e)** to calculate the M_r of sulfamic acid.

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(1 mark)

(g) Use your answers to **Part 1** and **Part 2(f)** to deduce the molecular formula of sulfamic acid.

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(1 mark)

3 Assuming that any sulfur atom forms six covalent bonds, any nitrogen atom forms three covalent bonds, any oxygen atom forms two covalent bonds and any hydrogen atom forms one covalent bond draw a structure for a molecule of sulfamic acid.

(1 mark)

12

EVALUATING Full marks can only be scored in calculations if you show all of your working.

1 Suggest one reason why drying the hydrogen before recording its volume would increase the accuracy of the chemist's experiment.

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(1 mark)

2 Identify one other source of error in the chemist's experiment, apart from apparatus error. Suggest one improvement to minimise this other source of error.

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(2 marks)

3 Explain why an accurate value for the M_r of sulfamic acid is not needed to deduce its molecular formula.

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(2 marks)

4 The results of your experiment and the chemist's experiment produced conflicting evidence. Apart from operator errors, suggest one reason why the value for the M_r of sulfamic acid obtained by the chemist is more accurate than the value obtained in your experiment.

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(1 mark)

5 Explain why very concentrated solutions of the cleaner should not be disposed of down public drains. Suggest one way of making the acid safe before disposal.

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(2 marks)

6 The equation for the industrial preparation of sulfamic acid is shown below.

$$CO(NH_2)_2 + 2H_2SO_4 \rightarrow NH_2SO_3H + NH_4HSO_4 + CO_2$$

Calculate the atom economy of this reaction.

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(1 mark)

7 Sulfamic acid is a white crystalline solid under normal conditions. Suggest a reason why it is preferred to sulfuric acid as the main ingredient in de-scalers.

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(1 mark)

END OF QUESTIONS

10

GENERAL CERTIFICATE OF EDUCATION
JUNE 200X / JUNE 200X

DRAFT AS CHEMISTRY ISA: CHM3T SPECIMEN

ASSESSMENT and QUALIFICATIONS ALLIANCE

TASK SHEET

Skill assessed **Implementing (8 marks)**

The M_r of sulfamic acid

Sulfamic acid is a derivative of sulfuric acid. It is a white crystalline solid at room temperature. Sulfamic acid is the active ingredient of many de-scalers. These are reagents which clean metal and ceramic surfaces. Sulfamic acid is a strong monobasic acid.

A commercial sample of a new household cleaner claims to contain an aqueous solution of sulfamic acid. You have been asked to identify the acid in the cleaner and determine its concentration as part of a "value for money" test of a range of cleaners. The determination of the M_r of the unknown acid is a first step in identifying the acid.

You are provided with a sample of an unknown cleaner of concentration approximately 1 mol dm^{-3}. Prepare a diluted solution of the unknown acid and titrate the diluted acid with the 0.100 mol dm^{-3} solution of sodium hydroxide provided.

Wear eye protection at all times.
Assume that all solutions are toxic and corrosive.

IMPLEMENTING

1 Using a pipette and pipette filler, transfer 25.0 cm^3 of the solution of the cleaner provided to a 250 cm^3 graduated volumetric flask and make the liquid level up to the mark with distilled or de-ionised water.
Have your solution checked by the supervisor before mixing the contents of the flask thoroughly.

2 Rinse the burette with the sodium hydroxide solution provided. Set up the burette and, using a funnel, fill it with the sodium hydroxide solution. Record the initial burette reading in a table of your own design on the Candidate Results Sheet.

3 Rinse a pipette with the **diluted** solution of the cleaner. Using this pipette and a pipette filler, transfer 25.0 cm^3 of the **diluted** solution of the cleaner to a 250 cm^3 conical flask.

4 Add 3 or 4 drops of **phenolphthalein** indicator to the conical flask.

5 Add the alkali from the burette until the mixture in the conical flask has a pale pink colour. Record your final burette reading in your table.

6 Rinse the conical flask with water and repeat the titration until you obtain **two** titres which are within 0.10 cm^3 of each other. (You should do no more than five titrations.)
Have one of your final burette readings checked by your supervisor.

7 Calculate and record the average titre.
Clearly indicate which titres you used in calculating the average titre.

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JUNE 200X / JUNE 200X

ISA CHM3T SPECIMEN

Candidate Results Sheet

ASSESSMENT and QUALIFICATIONS ALLIANCE

Centre Number | | | | | |

Candidate Name .....

Candidate number | | | | |

Results

Present your results in an appropriate form in the space below.

Average titre ..... cm^3