Sulphur Dioxide in Alcohol

Support Pack for Higher Chemistry
Researching Chemistry and Chemistry Assignment

Overview

Studying chemistry involves learning chemistry facts and concepts. It also involves developing particular skills. These include research skills, which may involve you in doing investigative experiments or researching information. The aim of this unit is to help you develop these chemistry skills. You will learn new chemical concepts, in some depth, however it is the development of skills which is the focus of the unit. In this unit you will find out through experimentation, the sulphur dioxide content in particular wines. Experimental procedures are included in the pupil support pack.

This Unit is split into 3 main sections and will take approximately 3 weeks to complete.

- Individual literature review (1.1 - internal)
- Group Practical Investigation (2.1 & 2.2 - internal)
- Individual Assignment Paper (Assignment - external)

Sulfur Dioxide Information

Sulphur dioxide (SO$_2$) has been added as a preservative to alcoholic drinks for centuries. Manufacturers refer to all sulphur compounds added to drinks as ‘sulphites’. The quantity of sulphites in wine is strictly controlled by legislation. Despite this, concern has recently been expressed that sulphites in wine can sometimes lead to undesirable health effects. As a result, many drinks manufacturers are trying to reduce sulphite concentration.

Analytical chemists have developed methods to accurately calculate the sulphite concentration in alcoholic drinks. These methods allow them to verify that the drink contains enough preservative to be kept fresh for a reasonable time, that it will not taste foul as a result of containing too much preservative and that the sulphite content is within legal limits.

Record Keeping

Although you will be working in groups at various points in this unit it is essential that you keep an up-to-date record of the work you have completed each day ensuring the record is dated and gives a detailed description of what you have done that day including

- Useful information including a minimum of two different sources and retrievable references
- Decisions you make
- Outline of practical work
- Allocations of tasks within the group (everyone needs to “do some chemistry”)
- Observations
- Problems you encountered and your ideas to solve them
- Results (including tables and graphs with headings and units)

Before you begin your Individual report you should decide who your group will consist of (no more than 4 people per group) and agree upon which investigation you will be working on.
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Investigation A – compare the concentration of sulphur dioxide in a dry white wine to that of a sweet white wine.

Investigation B – compare the concentration of sulphur dioxide between two wines from different countries.

Investigation C – compare the concentration of sulphur dioxide in white wine to that of a red wine.

Investigation D – compare the concentration of sulphur dioxide in wine to that of cider.

Individual Literature Review

Assessment Standard 1.1 Gathering and recording information from two sources relating to the chosen topic

In preparation for your practical investigation into sulphur dioxide content of particular alcoholic beverages you will individually carry out background research and produce a literature review providing relevant chemical information on your chosen topic. This review will:

- Be around three pages long
- Be focussed on the chemistry of your topic rather than general knowledge information.
- Include detailed explanations of the analytical technique you will be using.
- Provide any suitable formula equations, apparatus required and a detailed exemplification of how you will calculate sulphur dioxide content from your results.
- Reference at least two relevant sources of information/data.

The following focus questions can be used to help you get started. You do not need to answer all the questions in your review.

Focus Questions

- Why are sulphites added to added alcoholic drinks?
- What concerns are there surrounding sulphites?
- What methods can chemists use to determine sulphites in alcoholic drinks?
- What are the legal limits for sulphites?
- Chemists refer to two “types” of sulphur dioxide - combined and free. Describe the differences between the two.
- How can chemists determine the total sulphur dioxide content in an alcoholic drink?
- How are sulphites in an alcoholic drink converted to sulphur dioxide?
- How is a standard solution prepared?
- What units are used to describe sulphur dioxide concentration and how do they relate to other units of concentration?
Group Practical Investigation

Assessment Standard 2.1 Planning/designing the practical investigation, including safety measures

To overcome standard 2.1 you must produce an individual plan on the experimental work you will be undertaking in your group.

The plan must include:
- a clear aim for the practical research investigation
- the experiment(s) to be carried out
- the apparatus and materials required
- any relevant points that are required to ensure consistency and a ‘fair’ experiment.
- a clear and detailed description(s) of how the practical(s) should be carried out
- safety considerations
- observations/measurements to be made
- the individual roles and responsibilities of all members of the group.

Remember that your regular record should be used to document decisions made, references found, etc throughout the process.

Assessment Standard 2.2 Carrying out the practical investigation safely, recording detailed observations and results including units

To overcome standard 2.2 You must carry out your experimental work safely and record your results and observations ensuring that your are maintaining a regular record of your work. This will checked by your teacher throughout the practical work.

Your record must include:

- observations/measurements recorded in an appropriate format (table, line graph etc) including units
- your raw data (including if a balance has been tared)
- replicate measurements made
- relevant observations such as colours and colour changes
Experimental Procedure for Determining the SO₂ concentration in wine and cider

SO₂ concentration can be determined via the following redox titration, using starch as indicator:

\[
\text{SO}_2^{\text{aq}} + \text{I}_2^{\text{aq}} + 2\text{H}_2\text{O} (l) \rightarrow 4\text{H}^+^{\text{aq}} + \text{SO}_4^{2-}^{\text{aq}} + 2\text{I}^-^{\text{aq}}
\]

If a standard iodine solution of known concentration is added to a sample of an alcoholic drink, the iodine will react with any SO₂ present.

Once all of the SO₂ has been used up in the reaction, the remaining iodine will react with the starch to give a blue–black colour, indicating the end-point of the reaction.

The concentration of SO₂ in the alcoholic drink can be calculated since 1 mole of iodine reacts with 1 mole of SO₂ according to the balanced equation above.

Alcoholic drinks contain two different types of SO₂, namely free SO₂ and combined SO₂. However, in this investigation you will be measuring total SO₂, where:

\[
\text{total SO}_2 = (\text{free SO}_2 + \text{combined SO}_2)
\]

Safety! Wear safety goggles throughout the practical investigation.

Sulphuric acid and sodium hydroxide solutions are corrosive. Handle with care. Wash splashes immediately with running water.

Iodine solution is harmful. Handle with care. Wash splashes immediately with running water.
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<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wine</strong> (varying types)</td>
<td>2 × 25 cm³ pipettes or 2 x 20 cm³</td>
</tr>
<tr>
<td>Deionised water</td>
<td>2 × 250 cm³ conical flasks</td>
</tr>
<tr>
<td>2 mol l⁻¹ sulphuric acid (aq)</td>
<td>White tiles</td>
</tr>
<tr>
<td>1 mol l⁻¹ sodium hydroxide (aq)</td>
<td>2 burettes and stands</td>
</tr>
<tr>
<td>1 bottle of starch solution (1%)</td>
<td>Pipette fillers</td>
</tr>
<tr>
<td>1 bottle of standard iodine (aq)</td>
<td></td>
</tr>
<tr>
<td>0.00125 mol l⁻¹</td>
<td></td>
</tr>
</tbody>
</table>

**Determination of total SO₂**

1. Using a measuring cylinder, put 25 cm³ of sodium hydroxide solution (1 mol l⁻¹) into a 250 cm³ conical flask.

2. Add a 25 cm³ or 20 cm³ sample of wine to the conical flask using the appropriate pipette. Ensure everyone in your group uses the same volume throughout the experiment.

3. Swirl the flask gently and leave to stand for approximately 15 minutes.

4. Add 10 cm³ of sulphuric acid (2 mol l⁻¹) and 2 cm³ of starch solution to the flask.

5. Titrate with iodine solution (0.00125 mol l⁻¹). The end-point is indicated by the appearance of a blue–black colour that persists for at least 2 minutes.

6. Repeat until concordant results are obtained (within 0.2 cm³)

7. *The number of moles of total SO₂ present in 25 cm³ (or 20 cm³) of wine can be calculated. This can then be converted into a mass (in mg) of SO₂ per litre and compared to the manufacturer’s data.*
Individual Assignment Paper

Instructions for candidates
This assessment applies to the assignment for Higher Chemistry.

This assignment is worth 20 marks out of the total of 120 marks. The Course will be graded A–D.

The assignment assesses the following skills, knowledge and understanding:

- applying knowledge of chemistry to new situations
- selecting information from a variety of sources
- processing the information/data collected (using calculations and units, where appropriate)
- presenting information appropriately
- analysing the data/information collected/processed
- drawing valid conclusions and giving explanations supported by evidence/justification
- evaluating experimental procedures/practical investigations
- communicating findings/information effectively

In this assessment, you will have to investigate a relevant topic in chemistry and communicate your research findings in a report. This must relate to a key area of the Higher Chemistry Course. Your assessor will let you know how the assignment will be carried out and any required conditions for doing it. Your report must be completed independently.

The assignment has two stages:

- a research stage
- a communication stage

Research stage
You need to choose a relevant topic in Chemistry to investigate. Your assessor must review your chosen topic to check that it is appropriate.

Once you have chosen your relevant topic, you need to decide the specific aspect which you want to research. This will become the aim of your assignment. The aim may change during the research stage of your assignment, depending on the information you find.

Most of the work in this stage is to gather data/information. This could come from the internet, books, published articles or extracts, journals, an experiment/practical activity, or any other appropriate source.

Your information/data could include, for example: statistical, graphical, numerical or experimental data/information; notes taken from a visit or talk; notes taken from a written or audio-visual source; or extracts from publications. It must include experimental data from practical work you have carried out.

Downloads directly from the internet or copying directly from books may suggest to the assessor that you have not understood the chemistry involved. This may be considered plagiarism unless you acknowledge the sources carefully. It is always best to put things in your own words to make sure you really understand them.
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You must:

- Select sufficient sources of information/data that:
  - are relevant: how useful are they for your topic?
  - are reliable: who wrote them? Who published them?
  - have similar/different perspectives: do they agree or disagree with each other?
- Select sufficient relevant data/information from your sources. This must include raw data from an experiment/practical activity, and could also include extracted tables, graphs, diagrams and text.
- Record the sources you have used with enough detail to allow someone else to find them again. If one of the sources is an experiment/practical activity, then you need to record the title and the aim.

When using an experiment/practical activity as one of the sources of information/data, your assessor will give you instructions for this. The experiment/practical activity will not be assessed and you may carry out the experiment/practical activity as part of a group.

If you are working in a group to gather data/information, you must take an active part in this and choose your own sources of data/information.

**Checkpoint:** inform your teacher that you have finished the research stage.

**Communication stage**
In this stage of your assignment you need to select, process, present and analyse information/data from the sources you have gathered, and produce your report.

This stage will be conducted under a high degree of supervision. This means that:

- you will be in direct sight of the assessor during the period of the assessment
- you must not discuss your work with other candidates

In this stage of your assignment you can only use information/data that you have collected from your research. This may include, for example: statistical, graphical, numerical or experimental data; data/information from the internet; published articles or extracts; notes taken from a visit or talk; or notes taken from a written or audio-visual source. It cannot include a prepared draft report.

As a guide, your report should be 800–1500 words, excluding tables, charts and diagrams.
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The table below shows how many marks are available for each aspect of your report.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mark allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim(s)</td>
<td>1</td>
</tr>
<tr>
<td>Applying knowledge and understanding of chemistry</td>
<td>4</td>
</tr>
<tr>
<td>Risk assessment</td>
<td>1</td>
</tr>
<tr>
<td>Selecting information</td>
<td>2</td>
</tr>
<tr>
<td>Processing and presenting data/information</td>
<td>4</td>
</tr>
<tr>
<td>Analysing data/information</td>
<td>2</td>
</tr>
<tr>
<td>Conclusion(s)</td>
<td>1</td>
</tr>
<tr>
<td>Evaluation</td>
<td>3</td>
</tr>
<tr>
<td>Presentation</td>
<td>2</td>
</tr>
</tbody>
</table>

**Guidance on producing your report**

Your report should:

- have an appropriate structure with an informative title and headings, where necessary
- be clear and concise

Underlying chemistry should be included. Your report should contain:

- aim(s)
- underlying chemistry
- experimental procedure
- data/information
- evidence of processing, presenting and analysing data/information
- conclusion(s)
- evaluation
- references

**Aim(s)**
The aim **must** describe clearly what is to be investigated.

**Underlying chemistry**
Here you should explain how the underlying chemistry relates to your topic. The response might include: a statement of the chemical principles involved, formulae, chemical equations, calculations, chemical properties related to the bonding present.

**Experimental procedure**
Here you must include a description of your experimental procedure. Safety measures should be included. This may include clearly labelled diagrams.

**Data/information**
Here you **must** include sufficient data/information from your sources that is relevant to your investigation.

- This may include, for example, statistical, graphical, numerical or experimental data; data/information from the internet; published articles or extracts; notes taken from a visit or talk; notes taken from a written or audio-visual source.
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**Processing and presenting data/information**
This must include data/information that you have processed from your sources. This can include, for example: performing calculations, plotting graphs from tables, populating a table from other sources, summarising referenced texts.

It must be clear where the raw or extracted data/information that you processed came from.

You **must** present your processed data/information in appropriate format(s) from: summary, graph, table, or chart (one must be a graph, table or chart).

Think carefully about the format(s) you choose because it must be suitable for the information you are presenting.

Check that you have included, as appropriate:

- suitable scales
- units
- headings
- labels

**Analysing data/information**
To analyse the data/information from your sources included in your report, you will have to interpret the data/information by drawing out the relevant parts and identifying relationships that are relevant to your investigation. This may include further calculations.

**Conclusion(s)**
You **must** clearly state the conclusion(s) of your investigation. Your conclusion(s) must relate to your aim and be supported by what you have found out.

**Evaluation**
This should include an evaluation of your individual sources and an evaluation of the investigation as a whole.

You may include for example:

- significance/interpretation of findings
- validity of sources
- reliability of data/information
- evaluation of experimental procedure:
  - accuracy
  - adequacy of repetition
  - adequacy of range of variables
  - control of variables
  - limitations of equipment
  - reliability of methods
  - sources of errors, uncertainties
References
At the end of your report you must record the sources you have used, with enough detail to allow someone else to find them. You need to include the title and the aim of your experiment/practical activity.

Before submitting your report, check that you have included everything you need.

Useful Sources
http://www.sdaws.org/News/Articles/documents/Sulfur%20Dioxide.pdf

http://www.morethanorganic.com/sulphur-in-the-bottle


Acknowledgements
This document is a modified version of the SSERC and Learning and Teaching Scotland Curriculum Support Pack, 2001